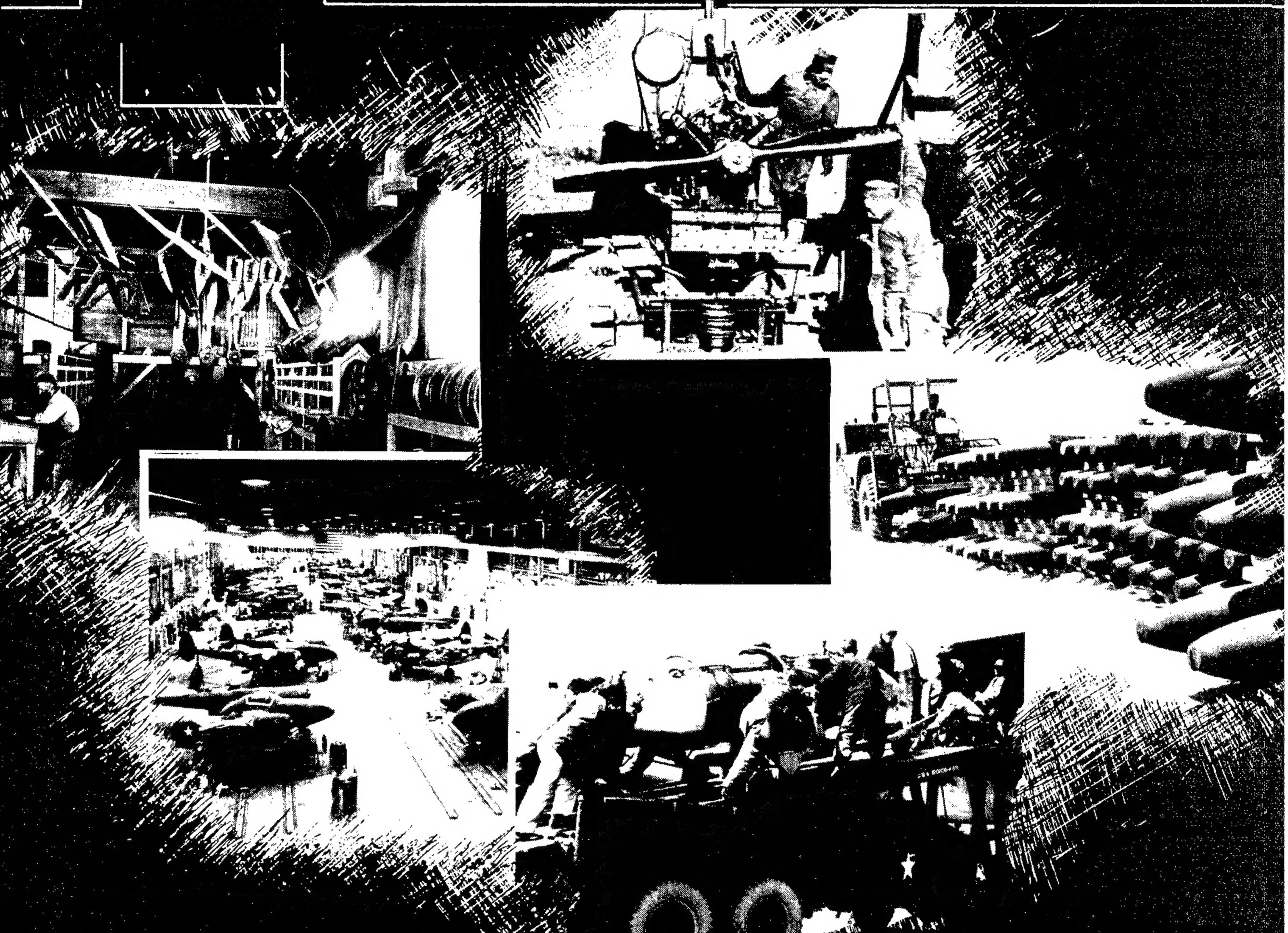
A Final Salute to AFLC

WINTER-SPRING 1993

AIR FORCE JOURNAL of LOGISTICS



AFRP 400-1

AIR FORCE JOURNAL of LOGISTICS

VOL XVII NOS. 1 & 2

WINTER-SPRING 1993

CONTENTS

ARTICLES

DEPARTMENTS

Purpose The *Air Force Journal of Logistics* provides an open forum for the presentation of issues, ideas, research, and information of concern to logisticians who plan, acquire, maintain, supply, transport, and provide supporting engineering and services for military aerospace forces. It is a non-directive, quarterly periodical published under AFR 5-7. Views expressed in the articles are those of the author and do not necessarily represent the established policy of the Department of Defense, the Department of the Air Force, the Air Force Logistics Management Agency, or the organization where the author works.

Distribution Distribution within the Air Force is F. Customers should establish requirements through the PDO system, using AF Form 764, on the basis of 1 copy for every 5 logistics officers, top three NCOs, and professional level civilians assigned. If unable to use the PDO system, contact the editor. *AFJL* is also for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Back issues are stocked at AFLMA/JL.

Manuscripts Manuscripts are welcome from any source desiring to deepen or broaden the knowledge and understanding of Air Force logistics professionals. They should be typed (double-spaced) and be between 1500-3500 words. Figures, graphics, and tables (separate pages) should be numbered consecutively within text. Author may send a diskette (ASCII file) along with the hard copy of the article (Address: AFLMA/JL, Maxwell AFB, Gunter Annex AL 36114; DSN 596-4087, Commercial (205) 416-4087). Articles may also be electronically submitted via DDN. Call for specific instructions.

Refereeing *AFJL* is a refereed journal. Manuscripts are subject to expert and peer review, internally and externally, to ensure technical competence, correct reflection of stated policy, and proper regard for security.

Support Planning in North American Aerospace Defense Command

Major C. Gregory Moulaison, CF

The order is given, battle staffs called in, units alerted, wheels up, and the operation is on. Commander-in-Chief, North American Aerospace Defense Command (CINCNORAD) forces are swiftly moving to their assigned beddown locations in support of NORAD's mission, the defense of North America. Operations and Logistics planners have played their part and the deployment flows smoothly. The US Transportation Command (USTRANSCOM) allocated airlift arrives on time to move forces in accordance with the time-phased force deployment data (TPFDD). The forces and support flow, and the essential logistics tail critical to the success of all operations begins to make its presence felt.

Introduction

The Operations Plan has been worked and reworked to ensure a timely deployment and successful employment of the fighters. However, the ultimate success of the NORAD mission is dependent upon the Logistics Support Plan. The mention of such a plan immediately brings to mind several questions: What plan? Is there one? Who is responsible for writing it? Who wrote it? Let's call in the LOGISTICIANS! As those of us in the logistics/planning arena appreciate, loggies always have a solution to any problem. Before we tackle the support issue, however, we have to first provide some background information on NORAD and its support planning organization.

Background

NORAD is one of three combined commands—NATO and Korea are the others—where US forces work with personnel from allied nations. In NORAD, Canadian (CDN) and United States military personnel have worked side by side since 1958; and, with the 1991 five-year renewal of the Canadian/US North American Aerospace Defense (NORAD) Agreement, will continue to do so until 1996.

The issue of support planning within NORAD, a binational command, is undoubtedly a complex one. To facilitate the command and control of all its forces, NORAD is divided into three distinct regions: the Continental US NORAD Region (CONR), the Alaskan NORAD Region (ANR), and the Canadian NORAD Region (CANR).

Logistics support of forces deployed to each of the three regions is the responsibility of the Air Combat Command (ACC) for US forces deployed within CONR and CANR, Pacific Air Forces (PACAF) for US forces within ANR, and Air Command (AIRCOM) for Canadian forces deployed within CANR (Figure 1).

To ensure that logistics planning supports operational requirements for both US and CDN forces, HQ NORAD logistics planners coordinate the development and production of all logistics support plans with the three major commands (MAJCOMs). HQ NORAD does not have a J4. This function is integrated into the J5P Deputy Directorate. The logistics planning staff consists of a mix of Canadian and US planners. No one ever said that planning in a "PURPLE" world would be easy.

The stage is set. We have multiple supporting commands, Canadian and US planners ready to tackle the issues, and deploying and receiving units waiting for guidance. How do the pieces of this intricate puzzle fit together? This is where the old reliable Base Support Planning Process (for Canada, NORAD Base Support Planning Process) fits into the equation.

Support Planning in CANR

The first issue worked, and the most complex, was the development of support plans for US fighters deployed to Canadian beddown locations. The signing of the June 1989 CDN/US Memorandum of Understanding (MOU) For Mutual Support provided both the authority and impetus for HQ NORAD to take the lead in the Base Support Planning Process.

The first step in the process was to develop NORAD Base Support Planning (NBSP) Guidance which provided direction to deploying US units and receiving Canadian Forces host bases. It also provided a standard methodology for developing logistics base support plans for forces deploying to Canada in support of CINCNORAD's Operations Plan. The Guidance was modeled after the United States Air Forces in Europe (USAFE) Collocated Operating Base (COB) Planning Guidance. As we all appreciate, loggies are always logical, occasionally brilliant; but it does not require a rocket scientist to figure out there is no requirement to reinvent the wheel. The USAFE Guidance provided a solid model, and we tailored it to accommodate NORAD's requirements. Representatives from HQ NORAD, ACC, AIRCOM, and Canadian Forces (CF) National Defense Headquarters (NDHQ) met and jointly produced the first draft NBSP Guidance.

NORAD base support plans, developed in accordance with the Guidance, will address deployment, reception, and sustainment; discuss supportability of wartime requirements; and identify

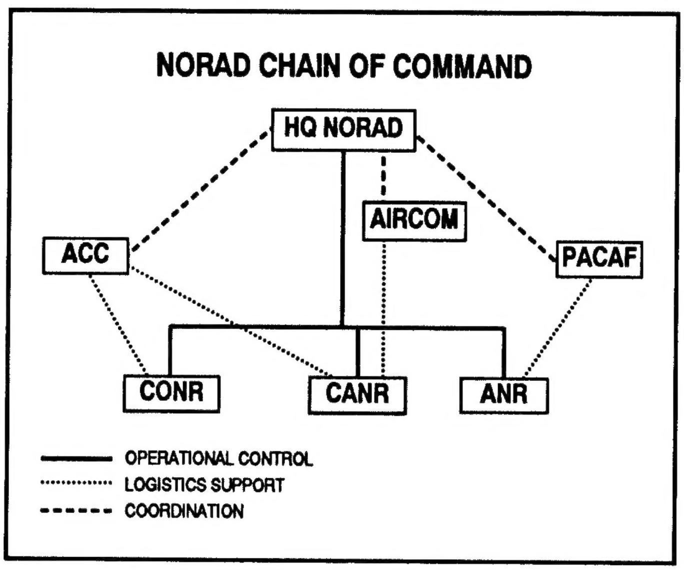
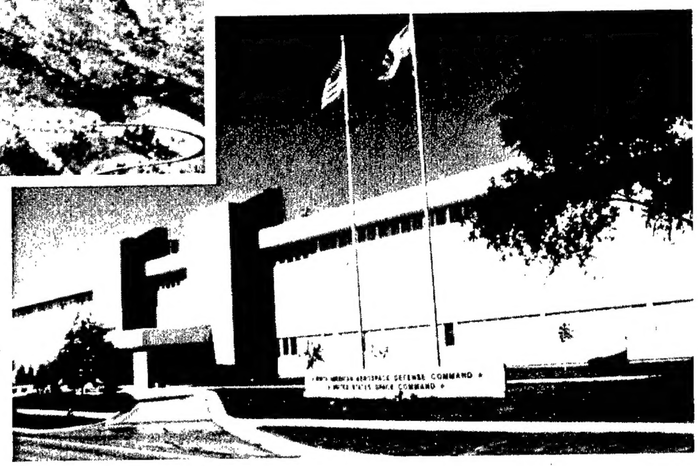


Figure 1.

Cheyenne Mountain–
"The Link to a Stronger Defense"

NORAD Headquarters



Underground Complex

Entrance to the Facility

shortfalls and limiting factors relevant to the deploying unit and host base. Each base support plan will be written by the deploying unit, not the supporting unit. Additionally, the plan will be written in sufficient detail for all to understand what must be done and who must do it.

To date, the first and only NORAD Base Support Plan applying the NBSP Guidance was produced at a planning conference, hosted by Canadian Forces Base (CFB) Cold Lake, in May 1991. First, a deploying US unit conducted a site survey of Cold Lake. Next, the site survey information was used to produce a draft NBSP which was forwarded to CFB Cold Lake for review and editing. The final step required a five-day NBSP conference at CFB Cold Lake. At this meeting, the deploying US and receiving CDN units jointly agreed on the extent of logistics support which CFB Cold Lake would provide. Following the conference, HQ NORAD, with the assistance of the supporting MAJCOMs, developed a three-year plan for the production of CANR NBSPs, with a projected completion date of 1995.

Following the development of the NBSP Guidance, which was initially intended for the use of US forces deploying to CANR, the issue of support to Canadian forces was considered. This issue proved to be far less complex. AIRCOM, which had been intimately involved in the development of the NBSP Guidance, agreed that the same document would be used to develop NBSPs for deployed CDN units. A three-year plan was developed, and the first CDN NBSP conference is scheduled for late 1993.

While the Canadian NBSP issue was being worked for US/CDN units deploying within CANR, the HQ NORAD Logistics staff concurrently worked BSP initiatives for CONR and ANR.

Support Planning in CONR

For the CONR region, the existence of Air Force Regulation (AFR) 28-31, *USAF Base Support Planning,* meant HQ NORAD would not have to initiate the development of a US-unique Base Support Planning Guidance. Generally, AFR 28-31 procedures are similar to the NBSP Guidance which is used to generate CANR-specific NBSPs. For example, both publications prescribe actions/resources to support/sustain wartime forces. Annexes and Tabs are organized by functional area. Additionally, limiting factors/shortfalls are identified and workarounds/resolutions provided. There are, however, two distinct differences. First, AFR 28-31 is US-specific, whereas the NBSP Guidance covers both US and CDN support requirements. Second, in CONR the receiving unit produces the BSP for the incoming US unit, whereas in CANR the deploying unit produces the NBSP.

Discussions between HQ NORAD and ACC confirmed the requirement to develop BSPs for US fighter units deploying within CONR in support of CINCNORAD's Operations Plan. ACC subsequently designated lst Air Force as their executive agent responsible for developing CONR BSPs. Significant progress has been made; numerous CONR site surveys have been completed, receiving unit points of contact have been assigned to write BSPs, and a three-year plan for the completion of all CONR BSPs is being developed. Following revisions to AFR 28-31 (July 93), the three-year plan will be finalized and the production of BSPs will commence. Projected completion date of the BSP process for CONR is 1996.

Support Planning in ANR

As indicated previously, BSP development in ANR proceeded concurrently with CANR and CONR developments. In ANR, there was no need to reinvent the wheel. AFR 28-31, the guidance used in CONR, was also used to produce ANR BSPs. However, ANR was required to utilize the PACAF supplement to AFR 28-31 to develop the ANR BSPs. This requirement necessitated NORAD/PACAF/11AF negotiations to ensure the supportability of each BSP. After briefings by the HQ NORAD logistics staff on the requirement to produce BSPs, 11AF, PACAF's executive agent, initiated work on the BSP issue. Currently, three of the five ANR BSPs are completed, and the remaining two will be completed by summer 1993. Upon finalization and approval of the BSPs, ANR will become the first of the three NORAD regions to complete the BSP process.

Summary

As is evident, the issue of support planning within NORAD, a binational command, is extremely complex requiring constant coordination among the numerous supporting staffs. The initiative to develop and produce the NBSP Guidance for support planning within CANR undoubtedly simplifies the support planning process. The NBSP identifies both the deploying units' support requirements and the extent of Wartime Host-Nation Support which it provides.

Attention is drawn to the difference in the approach to writing NBSPs in CANR and CONR. In CONR the receiving US supporting unit produces the NBSP, whereas in CANR it is the responsibility of the deploying unit. This difference in NBSP development procedures is both deliberate and essential for two reasons. First, the receiving CDN support base has neither control over nor understanding of the US logistics support system. Second, the deploying US unit assesses what the supporting CDN base will provide, compares it to overall support requirements, and then adjusts the TPFDD to meet operational requirements. In the final analysis, development of NBSPs will ultimately ensure supportability of CINCNORAD's Operations Plan.

Major Moulaison is presently Chief, International Plans, NORAD, Peterson AFB, Colorado.

Traditions of Excellence: A Final Salute to the Air Force Logistics Command

John C. Brownlee

Ever since a ground crew in August 1918 first spun the heavy wooden propeller of an MB-1 Martin Bomber and sent the earliest American-built warplane lumbering skyward, logistics has played a crucial role in our nation's air defense. While the logistics mission over the years to equip and maintain a combat-ready Air Force has remained largely unchanged, quantum leaps in technology, ever-evolving organizational skills, and shifting contingencies affecting national economic and political priorities have all helped to reshape the ways in which daily procurement, repairs, and modifications are made for Air Force weapon systems.

On 1 July 1992, out of the confluence of these historically reconverging forces emerged a new creation: the Air Force Materiel Command (AFMC). A product of the merger between the former Air Force Logistics Command (AFLC) and Air Force Systems Command (AFSC), the synthesis resulted in a partly-new and partly-old organizational hierarchy to administer Air Force logistics and acquisition processes. To better appreciate the significance of this landmark restructuring, a retrospective of AFLC's earliest days may reveal some of the circumstances that have contributed to the reformation of modern Air Force supply and maintenance practices.

World War I

Although AFLC's ancestry reached back to the wartime establishment on 14 July 1944 of the Army Air Forces Materiel and Services function, to ignore earlier events tells but half the story. Shortly after World War I, the US Army Air Service (predecessor to the present-day US Air Force created in September 1947) operated several air supply depots around the country, including one in Fairfield (now Fairborn), Ohio, near Dayton. One early assignment testing the logistical prowess of depot officials was managing the overseas return of many hundreds of biplanes that had served the 1917-1919 American Expeditionary Forces in France under General John J. "Blackjack" Pershing. Believing their actions proper, Army procurement officials, rather than loading the planes aboard freighters for the return trip home, to the surprise of bewildered onlookers, stacked the perfectly-good aircraft outside Paris and burned them. Shipping the fragile fighters back to the States, some believed, would cost more than the warplanes were worth. But opponents of the conflagration, outraged by what they considered scandalous waste, christened the pyre the "Billion Dollar Bonfire" and harshly rebuked the Army's interpretation of "cost-effectiveness." Even then, public scrutiny of military purchases sat like a watchdog over government spending perceived as profligate. Interestingly, however, acquiring and disposing of military hardware during World War I fell under the authority of a separate government agency, not the Army, a procedure which advocated that it was better to temporarily have civilians in charge of such tasks because they did not have military careers to protect.[1]

By the early 1920s, with only a few hundred enlisted men and a dozen officers, relatively simple repair shops worked to keep aloft the frail, moth-like bi-wings made of wood and cloth. Splintered propellers, sulky engines, and warped wings passed routinely beneath the sometimes fumbling hands of depot personnel new and unfamiliar with the fledgling art of airframe maintenance. Of the less than 1,000 aircraft owned by the US Army Air Service, most would soon fade into history. But until then, Gallaudet DB-1s, experimental Boeing GA-1 and GA-2 attack planes, and the de Havilland DH-4 "Flaming Coffin" (named for its unpredictable airborne propensity for spontaneously bursting into flames) were the usual sights one could expect chocked and pinioned along the tarmac of depot runways.[2]

The Air Service by 1921 had transferred command of the depot maintenance system from Washington DC to Wilbur Wright Field, Ohio (later Wright Field, and still later the current site of Wright-Patterson AFB, Area B). Reorganized and renamed several times over the following years, the developing supply and repair function faced its first major challenge in April 1924. The Army planned to launch four Douglas DW-C Cruisers on an unprecedented around-the-world flight, a journey staggering in its scope and likely to tax the most well-laid logistical plans. Supply and maintenance planners set to work. Carving the globe into six regions based on their climate, workers erected central depots in each of the zones and established smaller supply dumps at points in-between. Contracts with various petroleum companies assured adequate supplies of fuel and oil. Spare parts, emergency supplies, and basic provisions for the 26,000-mile flight were transported by nearly every conceivable conveyance—including sampan and canoe—to stock the way stations situated around the world.[3]

The prospect in 1924 of flying around the globe (three years before Lindbergh's historic *Spirit of Saint Louis* journey from New York to Paris) was serious business and not for the dull or feint-of-heart. Demanding the best of every man and woman involved, this bold and dangerous attempt also measured their inventiveness. They would have to calculate for every contingency, seen and unseen, and be frugal, giving up nothing to waste.

An example of this was constructing wooden crates. Provisions for the journey required many supply boxes. Crews built them from the same type of wood that had been used to construct the four airplanes. Emergency repairs could then be made in the field using the disassembled boxes without sending for distant and expensive wooden structural parts. And the system worked. On one leg of the flight, one of the planes, disabled by a faulty engine, found a replacement within only 100 miles. Finally, on 24 September 1924, two of the four Cruisers completed the arduous 175-day flight. More than three decades later in January 1957, three Air Force B-52s aided by aerial refueling and more refined logistics techniques, replicated the

historic trip, this time, however, flying around the world in just 45 hours.[4]

Perhaps in part persuaded by the novel feat of the Cruisers, and no doubt mindful of the future military aviation offered the country, President Calvin Coolidge, in September 1925, with the help of the J. P. Morgan banking firm, embarked on a five-year Congressional expansion plan to develop and produce airplanes for national defense. Slated to nearly double in size, the expanding Air Service would soon outrace its ability to warehouse and inventory the growing number of logistical supplies required to maintain its fleet.[5]

On 15 October 1926, the Army Air Corps (renamed the previous year from the Army Air Service for reasons of prestige), in an unwitting but evolutionary step toward the eventual 1961 formation of AFLC, created the Materiel Division. Headquartered at McCook Field in Dayton, Ohio, and later moved to Dayton's Wright Field in 1927, the Materiel Division under Brigadier General William E. Gillmore now consolidated several formerly disjointed logistics services into one command. Supply, maintenance, engineering, procurement and production, and industrial war plans would now be coordinated for the first time under a single authority.[6]

Hard Times

Throughout the Great Depression of the 1930s, the Materiel Division changed little. The four major air depots built during and shortly after World War I—at Fairfield, Ohio; San Antonio, Texas; San Diego, California; and Middletown, Pennsylvania—still overhauled the huge and powerful Wright and Allison radial engines. They had, however, also witnessed the arrival of a new generation of airplanes. By 1932, fabric and wood construction had essentially disappeared, making way for the first all-metal airframes. Instead of volatile "Flaming Coffins" and short-lived Boeings, sleek 600-horsepower, low-wing monoplanes with fearsome-sounding names of "Shrike" and "Nomad" now thundered onto runways in search of fuel and repairs. Although the swift new fighters outflew and outlasted their fragile predecessors, they required a more elaborate maintenance curriculum because of their metal bodies, a condition that gradually began to increase reconditioning costs.[7]

The Depression posed some unique problems for the Materiel Division. While maintenance expenses for advanced aircraft had begun to rise, so too had concerns for the few dollars to be found during those hard times. Consequently, the reality of the 1930s economy forced depot employees to make personal sacrifices. Unpaid administrative leave, hiring freezes, and lower-than-grade pay sometimes had to balance an otherwise precarious payroll. Moreover, before 1939, irregular labor conditions pervaded the Air Corps; pay, work hours, and civilian promotions varied from depot to depot. Even the length of the workday and workweek fluctuated. But despite the uncertainty of the era, and the occasional shortages and scattered working conditions, the logistics mission would soon face challenges of extraordinary and unparalleled dimensions—World War II.[8]

World War II

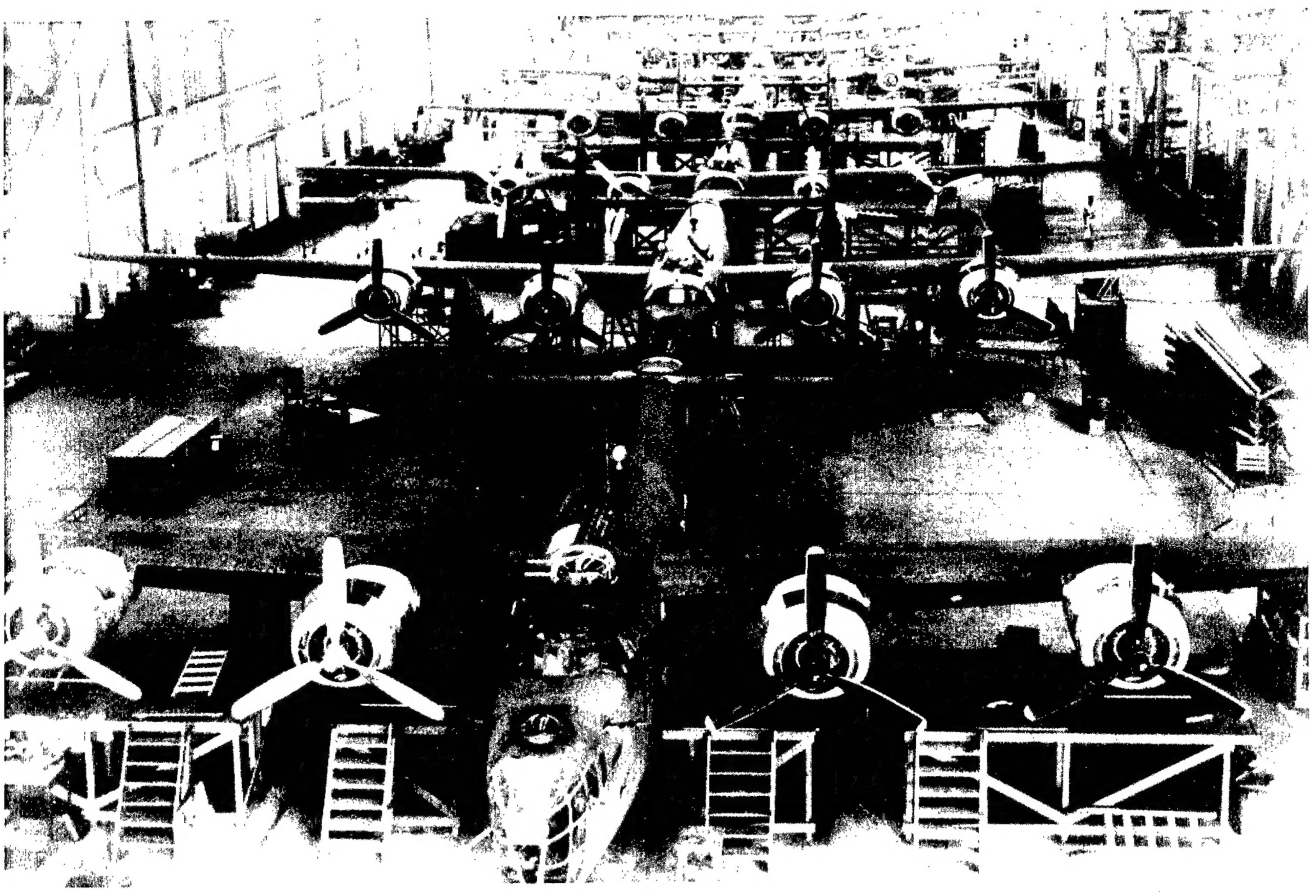
While Hitler and Hirohito hammered out battle plans to drive their borders through the forests of Europe and across the islands of the Pacific, and with the carnage of Pearl Harbor yet a year away, President Franklin D. Roosevelt stoked the fires to forge American industry into an "arsenal of democracy." Acknowledging the coming war as one which the country would have to win to help shape favorable postwar world, and dissatisfied with an outdated and understocked Air Corps' ability to fight a lengthy engagement, President Roosevelt called for a tenfold increase in the production of military aircraft. From an annual manufacture of 5,500 planes in 1940, to 50,000 in 1941, the warplane industry by 1943 was rolling out 125,000 airplanes a year. By the end of hostilities in 1945, American workers, a good many of them women, had produced nearly 300,000 fighters, bombers, and pursuit planes, a Herculean feat that rivaled the combined total assembled by Britain, the Soviet Union, Germany, and Japan.[9]

Unfortunately for logistics, during the first years of the war, developments in air supply failed to keep up with the more nimble production of aircraft. Little understood by Washington strategists, the merits of assembling crack logistics teams came quickly home to roost shortly after the surprise attack on Pearl Harbor. In January 1942, a dozen B-17 "Flying Fortresses" attached to the 9th Bomber Squadron flew the more than 12,000 miles to Java in preparation to stage bombing raids against the Japanese. Though they landed in record time, the eager bombers, one by one, soon stood silent on the tropical runways. Despite their rapid arrival, they had touched down halfway around the world without sufficient supplies to see them through their mission. Crippled without spare parts, repair facilities, or the means to maintain their aircraft, disabled squadron commanders soon had to leave Indonesia and hobble off to Australia. Though frustrating, the American military officials had experienced a hard-learned lesson on the value of developing adequate battlefield logistics in advance. But to design an adroit supply machine quick and agile enough to feed the voracious Air Corps combat forces in the European and Pacific Theaters, military planners first had to ferret out the weaknesses in the current system and pose solutions. Too few spare parts, inadequate forecasts of supply requirements, a shortage of trained supply personnel, and a lack of sufficient storage facilities emerged early as the chief culprits.[10]

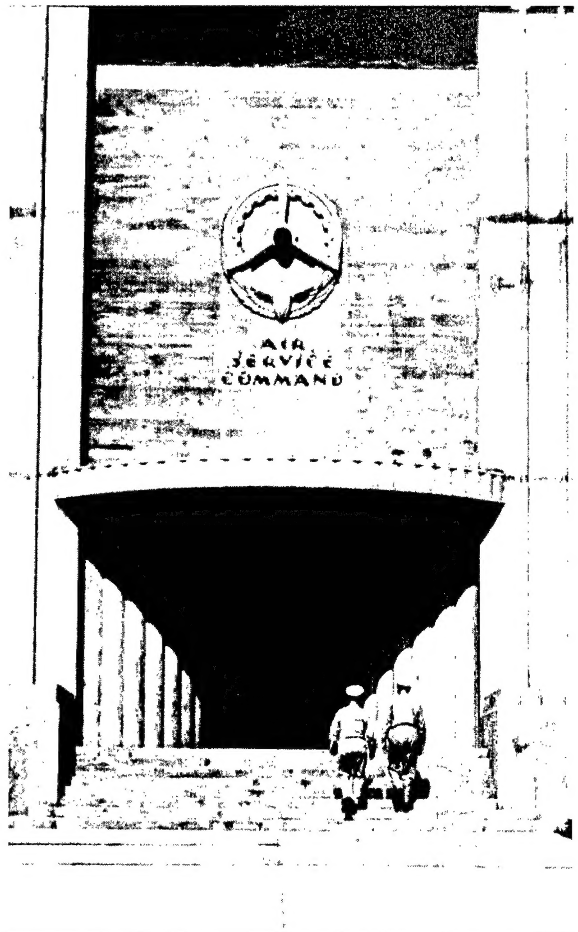
The war alone had not caused the shortfall in spare parts. Before Pearl Harbor, the Air Corps, as a part of its normal operations, routinely plundered 20% of its new airplanes to provide parts for in-service craft. Once the country was engaged in the war, however, the parts backlog exploded to immobilize nearly half the air fleet. As the building of new aircraft had been more profitable for aeronautical companies than their sole manufacture of spare parts, airplane companies prior to the war delivered only ready-to-fly planes without a complement of auxiliary components. Consequently, this practice unleashed a parts shortage that nipped persistently at the heels of supply personnel. But once engaged in combat, the government refused to accept any planes from manufacturers who did not also furnish the required repair elements.[11]

Procurement personnel discovered that it was a serious business of migraine proportions to forecast accurate supply and spare parts requirements, sometimes for as much as two years in advance, for the various air depots around the country. Never before had supply calculations been so crucial nor had they addressed operations of such magnitude. Logisticians had to design a system that not only revealed what parts to stock, but when and where to supply them. In August 1942, a solution finally arose in the form of the 15th Statistical Control Unit. Established at Patterson Field in Fairfield, Ohio, unit statisticians collated information which enabled logistics personnel to outfit their charges with the proper supplies. The chief instrument used to accomplish this task was the "Daily Airplane Status Report," a document which mapped not only the location of every broken airplane, but the reasons for its grounding, the parts needed, the

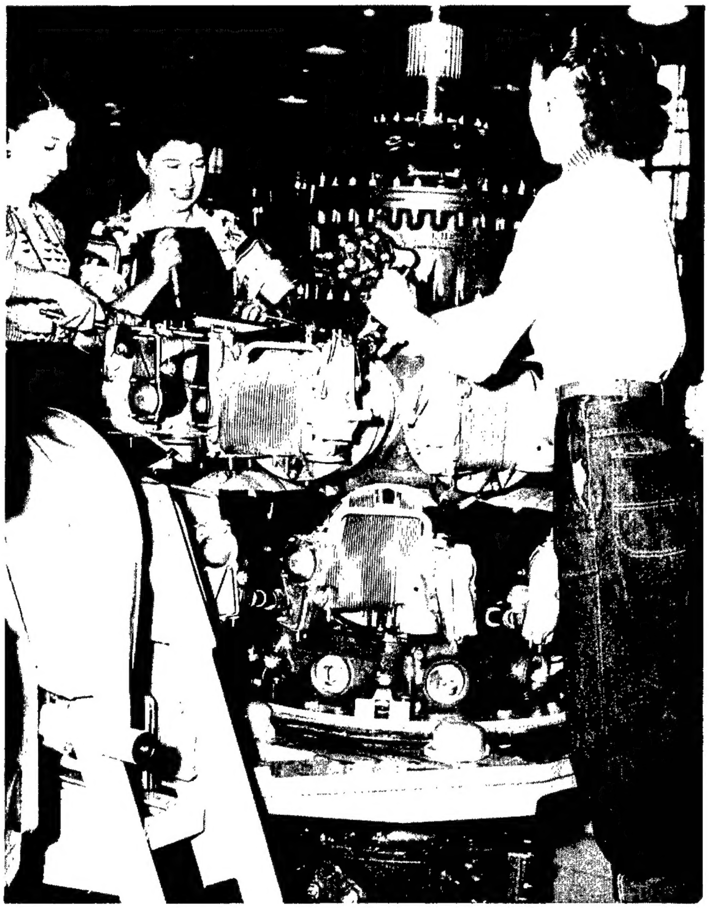
Airplanes at Fairfield Air Depot, May 1931.



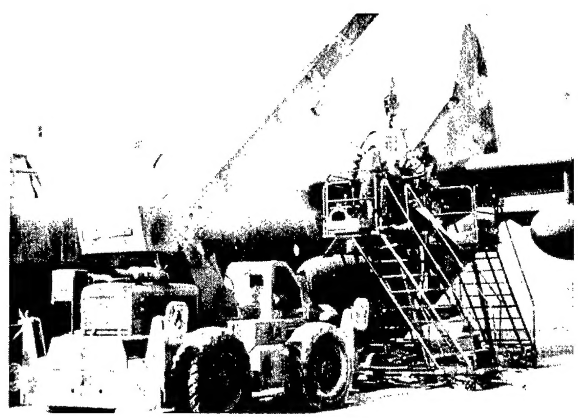
B-24 repair line at Hill Field, WWII.



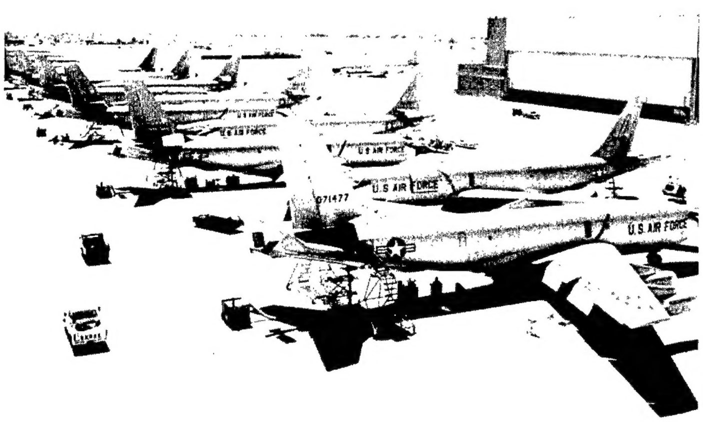
New headquarters of the Air Service Command, 1943.



Women doing engine maintenance, WWII.



Engine maintenance of C-130 aircraft, DESERT SHIELD.



KC-135 repair line at Oklahoma City, late 1960's

time down, and which pieces failed most often. For the first time, logistics had become a science to predict future supply needs.[12]

Soon, additional depots dotted the country to relieve the now overcrowded and war-burdened storage facilities. The expansion required more and more skilled hands to shift the complicated levers of supply and maintenance. Not only were persons experienced in logistics becoming harder to find, so too were those untrained people so desperately needed to perform clerical tasks and to staff warehouses. America was at war, and the Army, Navy, Marines, and private industry (which paid more than Civil Service) also plumbed the same manpower pool. Thus, competition often drained away those qualified men who otherwise could have twisted wrenches and rebored cylinders. But help was just around the corner in the nation's kitchens and living rooms. Collectively known as "Rosie the Riveter," an imaginary yet heroic female who traded her dust mop and dish rag for a torch to build bombers and battleships, legions of females joined the work force during the 1940s. Women eventually filled nearly 50% of all depot positions, a fact which finally eased the human shortage, and in some ways, planted the seeds for the later women's movement of the 1960s.[13]

Army Air Forces Materiel and Services

Wartime efforts to solve unusual tactical and strategic problems left in their wake a host of reorganizations. One of those changes produced AFLC's "grandparent" organization. On 14 July 1944, a few weeks after allied forces had stormed the beaches at Normandy and began their sweep across Europe to bring down Hitler, the Army Air Corps established the Army Air Forces Materiel and Services at Patterson Field (adjacent to Wright Field) as its major logistics command. Although redesignated several times over the next few years to become the Air Materiel Command (AMC) in 1946, this command brought together functions previously divided since 1941. Supply and maintenance, formerly under the Air Service Command, now merged with engineering and procurement, once under the Materiel Command. Before World War II, the Materiel Command and the Air Service Command functions had all operated under the Materiel Division established in 1926. Baptized in the fires of World War II, and seasoned by the intervening war years, logisticians by 1945 had come to develop a more sophisticated organization from which to fuel America's air power. But other unforeseeable challenges lay in the years ahead. The Cold War and the Space Age would present new knots to unravel in the sometimes tangled network of logistics.[14]

The Cold War

Tending the needs of what had by September 1947 become the US Air Force, AMC entered a postwar period dramatically unlike that of the early 1940s. Although Air Corps B-29s—the *Enola Gay* and *Bock's Car*—had in August 1945 brought down an atomic curtain on the Pacific Theater to end the war, the bombers had also ushered in a new age of international fear and distrust. Soon labeled the Cold War, this era brought forth a fresh mission for the United States Armed Services: a continuous vigilance against the threat of worldwide Communist expansion. For Air Force logistics, vigilance meant a constant state of preparedness to mobilize and support conventional or nuclear forces against the Soviet Union or China. The unfolding scenarios in Eastern Europe, the 1948 Berlin Airlift, the Korean War, and the 1953 Soviet tests of the hydrogen bomb had all conspired to convince American Cold Warriors within the Truman (and later Eisenhower) Administration that the Soviet Union and her allies fully intended to unfurl a Marxist-dominated world. To counter those fears, defense strategists positioned the US Air Force on the leading edge of the free world's defense.

Developmental revolutions in technology during the 1950s had also retuned the engines of logistics. With the advent of jet propulsion and ballistic missiles, the gears of combat turned much faster than they had in the propeller-driven days of World War II. As a result, AMC strived to keep the flexible pipeline of supply and maintenance at least full enough so as not to dip below a level of constant readiness. While McCarthyism fanned the fears of Communism, and as President Dwight D. Eisenhower held the line against its spread, new ideas of administration and the application of modern technology would transform Air Force procurement and maintenance procedures. The notions of modern management skills, electronic data processing, advanced inventory and communication methods, and better transportation and manufacturing procedures, inaugurated under General Edwin W. Rawlings, AMC Commander from 21 August 1951 to 28 February 1959, became the priorities for the Air Force logistics team in the decade preceding the Vietnam War.[15]

Air Force Logistics Command

On 1 April 1961, the Air Force changed the name of the Air Materiel Command to the Air Force Logistics Command. Procurement responsibilities would now fall under the auspices of AFLC. Adopting a system-management philosophy, Air Force planners had earlier split the design stage from the procurement stage of AMC-administered logistics to shorten the lead time between the research phase of a new weapon system and its enlistment into service. Over the course of nearly a decade, those same policymakers struggled among themselves to fine-tune the management of these tasks. Like so many other events in history, this conflict would ultimately be largely decided by outside forces. Early in 1961, Secretary of Defense Robert S. McNamara, taking an initial step toward fulfilling President John F. Kennedy's inaugural interests in the fledgling US space program, put the Air Force in charge of the military space program. In doing so, he ordered the Air Force to mold its organizations to this task. As a result, a new command, AFLC, had emerged that April and would oversee the requirements, funding, budgeting, and all duties relevant to the control of spare parts supporting weapon systems.[16]

Vietnam

Fighting a controversial and painfully persistent war to halt the spread of Communism in Southeast Asia—especially so after the surprise 1968 Tet Offensive—not only tested the sons and the patience of the American people, but the action also provided the first trial since Korea for a modernized Air Force logistics system. The central challenge for AFLC procurement and supply specialists became the rapid buildup of bases across the steamy recesses of Southeast Asia that would underpin the strategic and tactical support necessary to the air and ground war in Vietnam. Ordered by President Lyndon B. Johnson after the 1964 Gulf of Tonkin incident, in which North Vietnamese gunboats had reportedly attacked naval vessels *USS Maddox* and the *USS Turner Joy,* operation "Rolling Thunder" moved to bring the conflict to a swift and final conclusion by pounding North Vietnam to its knees beneath a relentless fury of B-52 bombing raids. As a result of the vigorous US offensive, and under code name "Project Bitterwine," AFLC channeled, for nearly a

decade, gigantic volumes of supplies to new and existing US air bases in Thailand, Taiwan, Japan, the Philippines, Okinawa, and South Vietnam.[17]

The experiences of Vietnam prepared Air Force planners for what former AFLC Commander General Jack J. Catton (1972-1974) dubbed "the logistics of deterrence." AFLC, by virtue of its long and varied experience in Southeast Asia patching flak-blasted F-4 Phantoms and crash-damaged C-7 Caribous, had by the 1970s, come to laud logistics itself as a persuasive foil against enemy aggression. General Catton knew wartime opponents evaluated both the weapons and manpower of their foes, and especially judged their ability to supply and maintain them under battlefield conditions. Consequently, if an enemy perceived the presence of strong and resilient US Air Force logistics, able to provide an endless stream of maintenance and supplies despite the toughest assaults, then that aggressor might reexamine its options before engaging a resourceful American air power. In fact, all succeeding AFLC commanders supported this principle, and the notion of deterrent-based logistics became a command theme for the rest of the 1970s and into the 1990s.[18]

The Troubled 1970s

As the war in Southeast Asia wound down, however, so too did the nation's political and economic affection for the military-industrial complex. Like the hearth-and-home nostalgia that had followed World War I, Americans, weary from watching a long and distant contest on their televisions, now looked askance at any hint of unbridled defense spending in the post-Vietnam era. Worse, a cauldron of bitterly divisive social issues in the 1960s and early 1970s had boiled over and spilled onto the streets. Disputes over civil rights, gun control, abortion, the police, and the long-term blistering exchange over US involvement in the war had alienated Americans even further from their government. Soaring inflation, falling budgets, and an energy crisis had also joined hands to divert federal funds away from defense programs under a peacetime Carter Administration, one whose priorities sought to soothe troubling domestic problems. Unavoidably, for AFLC and other military agencies, the age to "do more with less" had arrived.

To meet the resulting cuts in defense spending, while at the same time keeping abreast of continuing developments in missile and computer technology, AFLC periodically imposed manpower reductions. In 1970, for example, command personnel numbered around 134,000. But by 1976, worker ranks had dwindled to 97,000, and in 1980, employee totals sank to 90,000. In comparison, the combined military and civilian AFLC work force had in 1957 totaled nearly 225,000. One reason AFLC could so drastically reduce employee strength and still fulfill the logistics mission rested on the shift in strategic defense priorities from airplanes to missiles. Simply, missile maintenance was less labor-intensive than conventional aircraft and required fewer hands. Additional cost-conserving measures included the realignment of command functions and the reorganization of others.[19]

In an age of shrinking budgets, alarmed AFLC policymakers of the mid-1970s not only had to cut costs, but they also chalked plans to stretch existing resources. Aging depot facilities, many of which predated World War II, required elaborate remodeling schedules to preserve their survival in the absence of more modern replacements. Moreover, the mainstays of the Air Force mission, aircraft, also needed facelifts and in some cases, reconstructive surgery. In one major renovation scheme, some resources were stretched literally. The C-141 "Starlifter" remodeling program, administered by AFLC, extended the life, payload, and capabilities of the already-mammoth transport. It also added 23 feet to the midship fuselage and the capacity to refuel in midair. After the B-1 bomber program failed to materialize in 1977, the B-52 arsenal also had to be unexpectedly upgraded under AFLC supervision to accommodate new avionics and the Cruise missile. Acknowledging the lives of both tactical and strategic fleets had to reach beyond original expectations, AFLC commanders began to consider long-range conservation and preservation techniques that would compensate for the now-scarce defense dollars.[20]

Prosperity and Decay in the 1980s

By the mid-1980s, time and patience had closed some of the social wounds opened during the preceding decades. National unity and a sense of renewed patriotism had in many cases replaced the earlier feelings of separation, alienation, and powerlessness. The Presidency of Ronald Reagan had rekindled the national spirit, and much of that renewal relied on a return from years of inertia to a strong national defense. A short-lived 1983 skirmish in Grenada and a 1986 surgical air strike over Libya had, in the minds of many Americans, now restored the reputation of the United States to its proper stature in the world arena. As a result, lingering frustrations left by the Vietnam war, the grinding humiliation of the 1980 Iran hostage situation, and the 1983 horror of the US Marine barracks bombing in Lebanon had been somewhat vindicated, freeing a relieved America to confront two demanding and unruly domestic issues: a rampant federal deficit and the crumbling environment.

Between 1980 and 1985, national defense programs had enjoyed a sharp increase in funding, not only to rebuild from the lean Carter years, but also to keep pace with Soviet conventional military force. But by 1985, worried over the looming federal deficit, a troubled Congress had enacted the Gramm-Rudman-Hollings initiative, which mandated substantial cutbacks in defense spending. AFLC resources plummeted from a 1985 high of $7.3 billion to $6.1 billion in 1988, forcing Command leaders to reduce critical functions while maintaining sufficient levels of service to fulfill the logistics mission. Proposed civilian employee furloughs, reduced travel and overtime allowances, restricted LOGAIR transportation services, and reductions in base and depot maintenance were some of the ways in which AFLC policymakers reduced costs to meet shortfalls in their annual budgets. And, from the view of 1988, fiscal prosperity did not appear to be much in the immediate future.[21]

The quality of the environment, especially on important military installations such as those operated by AFLC, had by the 1980s also attracted the national spotlight. Under riveting public attention, the quest to follow the sometimes conflicting federal, state, and regional environmental regulations, while still maintaining an acceptable level of daily operations, arose to challenge AFLC's best planners. For instance, Wright-Patterson AFB, and its 8,000 acres, like most large and aging industrial complexes, had its share of problem areas. Most of them had gradually accumulated from a time when environmental sciences were yet unsophisticated. Previous generations had possessed little knowledge of hazardous materials and, consequently, were unwitting in their now-improper disposal methods. As a result, the relatively recent problems of asbestos removal, clean water, toxic wastes, radioactive spills, and radon gas converged in force to confront base environmentalists. Simply, what had taken generations to collect could not be easily

removed overnight, despite the desires of AFLC scientists and the insistence of stern environmental wardens. Like many human problems, whether social or technological, it would take an unflinching perseverance over time before such conditions could be stripped from the Command's bases.

Into the Future

Although environmental sensitivities of the 1980s had lured AFLC planners underground to plumb the soils of Wright-Patterson and its affiliate air logistics centers searching for subterranean fuel spills and tainted water tables, futuristic strategic and tactical technologies had by then surfaced. Such techniques would lead AFLC to better management procedures to support new and evolving weapon systems, such as the Stealth fighters and bombers, and the C-17 transport, the airlifter of the twenty-first century. One of the more challenging and comprehensive of those sciences involved the Logistics Management Systems (LMS) Modernization Program. In 1982, at a projected cost of nearly $1.7 billion, and designed to replace by the 1990s some 135 antiquated, batch-processed information systems in use since the late 1970s, the first LMS computers began to coordinate the basic AFLC functions: logistics requirements, acquisition, distribution, and maintenance. Using nine fundamental and five support systems, LMS would ensure that AFLC logisticians had at their immediate disposal information to "get the right part to the right place at the right time."[22]

Unlike the previous and unsuccessful efforts of the 1960s and early 1970s, when AFLC attempted the wholesale installation of then-modern computer networks to tame the growing reams of unmanageable paperwork, LMS would gradually be phased in over time, step by step. This strategy permitted AFLC technicians to test and activate each component before adding a successive element, thereby observing more cost-efficient installation measures. Shorter lead time for acquisitions, reduced shipping intervals for spare parts, and better planned aircraft maintenance schedules would be the result. Through the LMS system, AFLC would ultimately enhance its ability to support a sustained war and remain true to the notion of "deterrence through logistics."[23]

And by the 1990s, AFLC was tested once again under battlefield conditions, this time in the 1991 Persian Gulf War, also known to the US military as Operations Desert Shield/Desert Storm. To meet the challenge, the Command, among its other war-related contributions, deployed 1,702 personnel worldwide. Air-transportable War Readiness Spares Kits (WRSK),* Standard Air Munitions Packages (STAMP), and Standard Tank, Rack, Adapter, and Pylon Packages (STRAPP) provided initial spares and munitions assets. At the depot level, AFLC accelerated Programmed Depot Maintenance (PDM) of 70 aircraft and "surged" the production of more than 90,000 commodity items. And because of superb logistics and maintenance mechanisms, Air Force aircraft enjoyed a fleet-wide availability rate of almost 90%.[24]

Following the inauguration of AFLC's Integrated Weapons System Management (IWSM) program in the early 1990s, Air Force logistics was again reorganized into a new command. In the summer of 1992, amidst withering resources, pressing environmental concerns, and the advent of new state-of-the-art weapons management systems, the Air Force Logistics Command passed into history, leaving in its wake a new command, the Air Force Materiel Command, organized for the challenges of the next century. From the lessons learned in wars and depressions, and from the knowledge gained in new technologies, AFMC will excel because of the experiences of its predecessor organizations and stand as a critical centerpost beneath America's air defense.

*(now Readiness Spares Packages (RSP))

Acknowledgement

We gratefully acknowledge the assistance of John Weber, AFMC Historian, and William Elliott, AFMC Staff Historian, in developing this special section.

Notes

[1] Ravenstein, Charles A. *The Organization and Lineage of the United States Air Force* (Office of Air Force History: 1986), p. 13; Waters, Andrew, *All the U.S. Air Force Airplanes, 1907-1983* (New York NY: 1983), pp. 60-62; AFLC Hist. Study No. 329, "Air Force Logistics Command, 1917-1976," pp. 1-2.

[2] Waters, pp. 60-62; AFLC Hist. Study No. 232, "The Maintenance of Army Aircraft in the United States, Part I," pp. 32-33.

[3] AFLC Hist. Study No. 329, p. 2; AFLC Hist. Study No. 280, "History of the Army Air Forces Air Service Command, 1921-1944," pp. 5-6.

[4] AFLC Hist. Study No. 280, pp. 5-6.

[5] Goldberg, Alfred. *A History of the United States Air Force, 1907-1957* (New York NY: 1957), p. 36.

[6] AFLC Hist. Study No. 329, pp. 2-3.

[7] AFLC Hist. Study No. 232, p. 40; Waters, pp. 63-65.

[8] AFLC Hist. Study No. 262, "The Evolution of the Storage System of the Air Technical Service Command, Part I; 1918-1940," pp. 27-28.

[9] Craven, Wesley F., and Cate, James L., eds. *The Army Air Forces in World War II* (Chicago IL: 1955), Vol VI; Goss, William A., et al., *Men and Planes*, pp. 173-174; Bailey, Ronald H., et al., *The Home Front: USA Time-Life Series on WW II* (Alexandria VA: 1977), p. 82; Link, Arthur S., *American Epoch: A History of the United States Since the 1890s* (New York NY: 1962), p. 512.

[10] Coleman, John M. *The Development of Tactical Services in the Army Air Forces* (New York NY: 1950), p. 13; AFLC Hist. Study No. 263, "The Evolution of the Storage System of the Air Technical Service Command, Part II; 1941-1945," pp. 38, 43-49; Craven and Cate, pp. 347-48.

[11] AFLC Hist. Study No. 263, p. 47; Craven and Cate, pp. 347-48.

[12] AFLC Hist. Study No. 263, pp. 37, 167-68.

[13] Ibid., pp. 43-47.

[14] Ravenstein, p. 13.

[15] AFLC History Office, "Logistics and Management Philosophies of AFLC Commanders, 1961-1972," pp. 1-8; Rawlings, Gen E. W, "A New Equation for Jet-Age Logistics: Electronics Steps Up Air Supply," *Air University Quarterly Review*, Vol VII (Spring 1955), pp. 8-9.

[16] AFLC Hist. Study No. 334, "History of the Air Materiel Command/Air Force Logistics Command, 1 July 1960 - 30 June 1961," pp. 44-46, 57-63, 85.

[17] AFLC Hist. Study No. 358, "AFLC Support of Forces in Southeast Asia; Supply Support," Vol I, pp. 24-26, 36-39; Joint HQ AFLC/HQ PACAF Materiel Support Plan for New Main Operating Bases, 12 August 1965.

[18] Catton, Gen Jack J. Address to the Armed Forces Staff College, 28 February 1973.

[19] AFLC Hist. Study No. 391, "History of the Air Force Logistics Command, CY76," pp. 19-23; AFLC Hist. Study No. 329, Appendix 3; AFLC Hist Study No. 392, "History of the Air Force Logistics Command, CY77," p. 9; AFLC Hist. Study No. 394, "History of Air Force Logistics Command, CY78," p. 55; AFLC Hist. Study No. 397, "History of the Air Force Logistics Command, CY79," p. 44; AFLC Hist. Study No. 400, "History of the Air Force Logistics Command, FY80," p. 465; AFLC Hist. Study No. 375, "History of the Air Force Logistics Command, FY70," pp. 35-40, 45.

[20] AFLC Hist. Study No. 388, "History of the Air Force Logistics Command, 1 July 1974 - 31 Dec 1975," p. 108; AFLC Hist. Study No. 380, "Depot Plant Modernization," pp. 9-14, 16, 38, 40; AFLC Hist. Study No. 391, pp. 58, 216-17; AFLC Hist. Study No. 392, p. 30; AFLC Hist. Study No. 394, pp. 59-60; AFLC Hist. Study No. 397, p. 49; AFLC Hist. Study No. 400, pp. 71-78.

[21] Talking Paper, AFLC/ACBO, 13 April 1988, Subj: AFLC FY88 O&M Status & FY89 Outlook; Briefing, AFLC/AC, October 1988.

[22] Fry, Ron. "The Right Part to the Right Place," *Air Force Magazine*, March 1989, p. 106.

[23] Ibid., pp. 106-112.

[24] "FY 1991," *AFLC Annual History*, pp. 197-262.

John Brownlee was assigned to the AFLC Office of History when he wrote this article and is presently Historian, Phillips Laboratory, Kirtland AFB, New Mexico.

C-141 Depot Maintenance: Using Simulation to Define Resource Requirements

Colonel Thomas F. Schuppe, USAF
Captain David V. McElveen, USAF
Captain Peter H. Miyares, USAF
First Lieutenant R. Garrison Harvey, USAF

Background

The throughput of C-141 aircraft in depot maintenance was adversely affected by the addition of two major, unanticipated tasks. Many constraints existed to improving the production rate; but, due to complex interrelated effects, it was difficult to determine which resource constraints were the most critical. A simulation model was developed as a policy evaluation tool to define potential throughput improvements resulting from increased resource availability. This tool provided management key insights and allowed them to focus their limited budget on adding those resources which provided the largest throughput increases.

Introduction

The C-141 aircraft is a four-engine jet aircraft used to haul cargo throughout the world. The aircraft is primarily used by the Air Mobility Command of the United States Air Force. The C-141 has been in-service since 1965, and there are currently 268 of these aircraft in the Air Force inventory.

Approximately every 60 months, each aircraft is flown to Robins Air Force Base, Georgia, to undergo Programmed Depot Maintenance (PDM). The Warner Robins Air Logistics Center (WR-ALC) at Robins is one of the Air Force's major maintenance depots and is responsible for all periodic maintenance, including PDM, on the C-141 aircraft. PDM is a process that inspects and repairs, as necessary, mechanical, electrical, hydraulic, and structural components of the aircraft. Approximately 1,500 people are dedicated to this C-141 PDM process at WR-ALC.

In 1990, Center personnel found serious wing cracks in a number of C-141 aircraft. These cracks were located in a major structural member that joined the outer wing with the inner wing. They decided that these cracks must be repaired as expeditiously as possible for safety of flight reasons. Also in 1990, other cracks were identified in the center wing box, a major structural subassembly, approximately 8 feet high, 22 feet long, and 18 feet across, which connects the wings to the fuselage. Passing through the wing box are a multitude of electrical, mechanical, hydraulic, and fuel lines. Due to the severity and location of the cracks, ALC personnel decided to replace the entire center wing box rather than repair it. The center wing box, which weighs approximately 6,000 pounds, was never designed to be removed from the aircraft and replaced.

When these two major structural problems were uncovered, WR-ALC was presented with the significant problem of accomplishing these repairs while also completing normal PDM on the C-141 fleet. The ALC was manned to handle only the PDM activity, and the impact of trying to take on the wing repair and the center wing-box replacement simultaneously was unknown. Consequently, the Center was faced with several major management decisions. The first was simply defining its existing capacity. It was also necessary to quantify the additional resources needed to complete both major repairs and the ongoing PDM. Resources included people; hangar space; test equipment; tooling; and, most importantly, money. Some excess capacity existed at the Center, but it was not clear how much additional capacity would be needed to accomplish these two unanticipated additional repairs that had never been planned or previously accomplished.

Choice of Simulation

C-141 depot maintenance at WR-ALC requires many resources, including manpower, facilities, and equipment to successfully maintain the C-141. The complex interaction between these resources and the maintenance functions competing for them makes forecasting capabilities and capacities of the system very difficult by standard analytical techniques. (2) Also, process and activity durations of the system are stochastic, making mathematical or heuristic evaluation techniques very difficult if not impossible to use. (4) Simulation was chosen as the evaluation tool for this project due to its ability to handle complex requirements for resources, as well as the stochastic processing times.

WR-ALC also recognized that resource constraints posed the major problem to substantially increasing throughput at the Center. Because of this, a tool which could identify these constraints and specifically quantify the impact of varying levels of resources was needed. Once specific constraints were identified, attention could be focused on alleviating these constraints, while ignoring other noncritical areas. This approach to problem solving, known as the Theory of Constraints, has been advocated by Goldratt and Cox.(1)

Air Force decision makers often place demands on the depot maintenance system without completely understanding its capacity. A prime example is the requirement to replace the center wing box on 90 C-141 aircraft by the end of FY95. The only center wing-box replacement data available was from a single prototyped aircraft done in a contractor's facility. Furthermore, it was not clear how the center wing replacement process would work with other on-going repair activities. The simulation provided managers a policy evaluation tool to determine if the center wing-box replacement process was achievable and to measure replacement process effects on the schedule of aircraft requiring other maintenance. The simulation was later useful in determining the impact of gaining additional hangars on the maintenance schedule and aircraft flowtime through the system.

The demand on resources was a critical concern. Decisions on future manning levels as well as future support equipment acquisitions were required. The simulation considered the complex interactions of the demands for particular resources, including facilities, manpower, and equipment. A good example was the utilization of nondestructive inspection (NDI) equipment and personnel. Several procedures within the maintenance process require NDI to search for cracks within the aircraft. The simulation was used to identify the best policy in assigning a number of NDI teams to each aircraft or to "pool" the NDI resources for better utilization and availability.

Processing and activity durations for the system are stochastic in nature. Although exact distributions for these times were not available, the most frequently expected value was estimated by experienced maintenance supervisors. WR-ALC gathered high and low values for each process through discussions with management and frontline supervisors within the Center. It then combined the data to form triangular distributions which were used in the simulation. Rework ratios, as well as fault detection rates, were gathered in a similar manner, compiled, and used within the simulation.

Model Description

C-141 maintenance is conducted year round, except for the 10 Federal holidays per year and an occasional day lost to bad weather. Two full 10-hour shifts work Monday through Thursday and a smaller 10-hour shift works Friday through Monday. In a typical year, 50 to 60 aircraft receive PDM and are repainted.

Initially, a model of the current PDM process was constructed using the SLAM II simulation language. (3) This model, shown in Figure 1, was a macro-view of the PDM process and grouped many smaller subprocesses into single activities. The structure, logic, and data of the model were reviewed with PDM experts from the Center. In addition, the model was exercised with nominal data. Measures of system throughput and resource utilization were reviewed to validate the model. Once the basic model was completed, additional detail was added to include the effects of incorporating the wing-crack repairs (speedline) and the center wing-box replacement. These additions are shown in Figure 2. An important point to note in Figure 2 is that a single aircraft will follow only one path through this process, from Aircraft Arrival to Aircraft Departure.

Speedline

The speedline program calls for the inspection and repair of cracks found in the aircraft wings and the possible replacement of the wing's beam caps which are wing joint support structures. The process is called "speedline" because the Center would like to accomplish the process on each aircraft as quickly as possible.

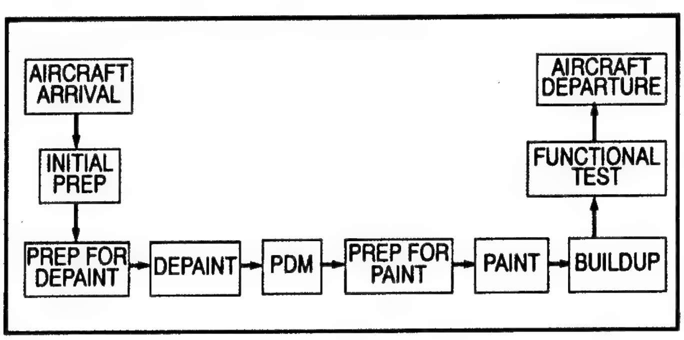


Figure 1. Initial Programmed Depot Maintenance (PDM) Process.

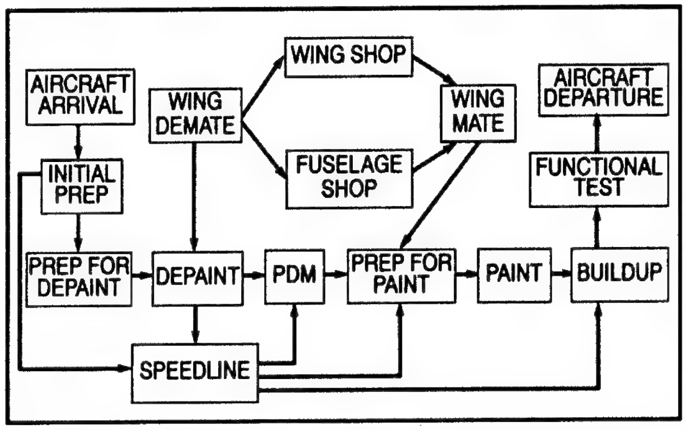


Figure 2. Programmed Depot Maintenance (PDM) Process with Speedline and Center Wing-Box Replacement Included.

The Center has two years to complete the process on 183 aircraft. Planners and engineers arranged and organized maintenance schedules and facilities in an attempt to process each aircraft through speedline to meet this requirement. Aircraft that had not received the speedline process within two years would be grounded. In order to meet this deadline, speedline aircraft must arrive at Warner Robins by 30 September 1993.

Some of the aircraft going through speedline are also to receive PDM and/or be repainted. When the speedline program is completed at the end of FY93, the normal PDM process will continue at Warner Robins.

The Speedline Process Flow

After an aircraft bound for speedline arrives at the Center, it receives an initial inspection and initial preparation (Figure 2). In addition, if the aircraft is going to be painted following speedline, the existing coat of paint must be removed shortly after arrival in a process called "depainting." The aircraft then receives additional preparatory work for speedline which varies depending on whether the aircraft is going to be painted and/or receive PDM.

Once prepared, the aircraft is towed to one of several hangar positions where the actual speedline process is conducted. If no hangar positions are available, an aircraft must wait until one is available. The speedline process itself is conducted on eight separate sections of the wings: the right and left, upper and lower portions of the forward and aft sections. The first phase of the process is a nondestructive inspection of all the rivet holes on a wing. All holes that do not pass this inspection must be redrilled and then reinspected. Prior to the reinspection, the wing undergoes two possible repairs. The first is the repair and replacement of cracked wing panels, required on about 90% of the lower forward sections. The second is the replacement of beam caps, which is required on about 12% of the lower aft sections.

Following these repairs and reinspection of the rivet holes, every aft section receives a gorilla fitting (a reinforcement for the wing joints), while additional wing work is conducted on the forward sections. Once this work is complete, the aircraft is prepared for and processed through PDM, if required. Then the aircraft is "built up," a process of reinstalling any systems or equipment removed during any part of the maintenance operation. Finally, the aircraft is functionally tested to ensure it is ready to be returned to service. Those planes requiring paint are then repainted.

Center Wing-Box Replacement

The center wing-box replacement program calls for the replacement of the C-141's center wing box, a structural support which attaches the wings of the aircraft to the fuselage and acts as part of the spine of the fuselage. Originally, the program called for 124 aircraft to receive new center wing boxes over the next four years, but the program has since been scaled back so that as few as 17 aircraft may receive new center wing boxes.

The remaining 107 wing boxes will be replaced either at the Center or by a civilian contractor. All center wing-box aircraft processed at Warner Robins will be repainted and most will receive PDM.

The Center Wing-Box Process Flow

Figure 2 also illustrates the center wing-box replacement process flow. Aircraft arriving at Warner Robins to receive a new center wing box will also receive an initial inspection, initial preparation, and depainting. After additional preparatory work, the wings are removed from the aircraft. The fuselage receives a new center wing box, while the wings receive the same repairs conducted in the speedline process. However, the speedline process associated with the center wing-box replacement program is independent of the other speedline process and is accomplished with its own facilities, personnel, and most of its own equipment. The majority of PDM is also accomplished while the center wing box is being replaced. This PDM work is also conducted by different personnel and equipment than the PDM conducted following the speedline process. Once all repairs are completed, the wings are reinstalled onto the aircraft and the remainder of PDM is conducted. The aircraft is then built up, tested, and painted.

Resource Sharing Within and Between Processes

It is important to note that the speedline and center wing-box replacement processes share very few resources. The aircraft are painted and depainted in the same facilities and by the same personnel. The depaint facilities are also used to wash and prepare aircraft for painting. The processes share a few pieces of equipment, and the initial inspection, initial preparation, and functional testing activities are all conducted by the same set of personnel regardless of which major repair processes an aircraft undergoes.

Resources are also shared with processes outside of center wing box and speedline. The buildup of the aircraft is conducted by the same personnel who accomplished the preparatory work or by the PDM crew in the case of a speedline aircraft that received PDM as well. If a problem is detected during functional testing, personnel from the process who completed that repair are called upon to fix it.

The Simulation Model

The simulation model of all C-141 maintenance activity at the Center was created using SLAM II and some additional FORTRAN subroutines. The model simulates the operation and flow defined previously over a planning horizon of four fiscal years. Its level of detail focuses on major repair activities as defined by the C-141 Production Division.

Some of the repair activities can be completed in parallel, while others must be completed in series. Most activities are order-dependent and cannot begin until one activity or a group of other activities are completed. Although the Center had been accomplishing PDM repair activities for over 20 years, no records were kept at the appropriate level of detail to define activity time distributions. Therefore, the duration of each activity was estimated, based on a triangular distribution whose median is the planned duration time in workdays provided by the Production Division. The simulation model assumes that most of these activities can be completed up to 20% ahead of schedule or 30% behind schedule, based on information provided by the Production Division. For modeling simplicity, some minor activities which must be accomplished in series are treated as a single large activity, if the resources required for the combined activity are the same as for the individual activities. For example, two half-day activities are treated as one full-day activity, if there are no changes in resource requirements.

The model processes each aircraft scheduled to enter the system over a planning horizon of four fiscal years (FY92-FY95) based on the type of repair required. This information is stored in an input data file and is accessed by the simulation model using a brief FORTRAN program. The input file contains two data elements for each aircraft, the planned workday of arrival and the type of work required. The day of arrival ranges from 1 to 1,416 based on the assumption that maintenance will occur 354 days a year over the four years of the program. The type of work required is classified by the following categories:

(1) Speedline only (81 aircraft).
(2) Speedline/paint (33 aircraft).
(3) Speedline/PDM/paint (46 aircraft).
(4) Center wing box/PDM/paint (62 aircraft).
(5) PDM only (46 aircraft).
(6) Speedline/PDM (23 aircraft).

The model does not allow speedline aircraft to enter the system after 30 September 1993, but work on all the aircraft already in the system by that date will continue. PDM aircraft do not arrive in the system until 1 October 1993, while center wing-box aircraft enter the system throughout the four years of planned operations.

Embedded in the model is an assumption that one workday is no different from another. It assumes any loss of work time due to worker nonavailability is embedded in the triangular distribution of the activity durations; that is, worker nonavailability is not explicitly programmed into the model, but is part of the reason the expected duration is sometimes exceeded by up to 30%. Also embedded is an assumption that most equipment and resources not explicitly modeled are always available to conduct work, or delays due to waiting for them are embedded in the duration distributions.

The resources and equipment explicitly modeled are the hangars for depainting and painting an aircraft, the speedline process, and the center wing-box replacement process; the facilities to conduct PDM and functional testing; and equipment to no load, water pick, and conduct nondestructive inspections on the aircraft. An aircraft requiring these resources must wait until that resource is available before proceeding with processing.

Hangars and facilities. For this system, maintenance hangars and painting facilities are the most critical resources. The C-141 maintenance operation has access to one depaint hangar and one paint hangar. However, both of these hangars are shared with C-130 and F-15 aircraft which are also maintained at the Center. The depaint facility is also used to wash and prepare an aircraft prior to painting.

The speedline process has six hangar positions; but, because of spatial constraints, two of these hangar positions have to be filled and emptied at the same time. Aircraft cannot enter either of these positions unless both positions are free and could not leave unless both were ready. This spatial constraint was

included in the SLAM simulation model. On 1 October 1992, two additional speedline hangar positions became available and were not spatially constrained.

The center wing-box replacement process has two hangar positions, in which wings can be removed or attached, and the facilities to repair four pairs of wings and six fuselages simultaneously. On 1 October 1993, the process will receive additional hangar space to process two additional pairs of wings and two additional fuselages. The PDM process can accommodate six aircraft at the same time, and functional testing can process four aircraft.

Imbedded in the model are the assumptions that, based on assurances from management, all necessary materials, personnel, and equipment resources are available to conduct the particular maintenance operations at each position. The only exceptions are:

No-load equipment. The no-load equipment is used to install and calibrate supports under the aircraft and wings in both the speedline and center wing-box processes. Only one set of equipment is available, and it is used on a first-come, first-serve basis.

Water picking equipment. The water picking equipment is used to clean speedline aircraft that also require PDM. Only one water pick is available, and it is used on a first-come, first-serve basis.

NDI equipment. NDI equipment is used to inspect rivet holes in the speedline, center wing-box replacement, and PDM processes. The number of NDI equipment sets available depends on the number of qualified technicians available to operate the equipment. Availability of qualified personnel varies by shift (10 sets/day shift, 6 sets/swing shift, 4 sets/weekend shift). Because the simulation model does not take shift differences into account, an average figure of 7 sets of NDI equipment is used. The actual numerical average of 6.7 sets is rounded up because more work is generally accomplished during the day shift. Priority for this equipment is given to speedline aircraft first, then center wing-box aircraft, and finally PDM aircraft.

Within the speedline process, NDI equipment remains with an aircraft until all inspections, repair work, and reinspections are completed on the rivet holes of each of the eight wing sections. The only exception is when a wing requires new wing panels and/or beam caps. If these repairs, which occur prior to reinspection, are required, the NDI equipment is used to reinspect the unaffected areas and is then released for use on other aircraft until these conditional repairs are completed. The aircraft is then allocated the first available set of NDI equipment to complete the reinspection process of the affected areas.

The model can also restrict the number of aircraft in the entire system as well as the number of aircraft processed through each operation at the same time. This is used to model a management policy of not removing too many aircraft from the active flight inventory at any one time, to control the flow in each process ensuring that a constraint is never left idle, and to reduce the amount of time an aircraft waits to enter any phase of the maintenance process.

Major Findings

Schedule Impacts

There are six possible paths a plane can take through the system. While there are many common nodes all planes pass through, and many separate nodes that compete for resources, this project concentrated on two aspects. Aircraft must go through either the speedline or the center wing-box replacement, but not both. While individual aircraft may require special activities, the schedule is driven by the need to complete 90 center wing-box replacements in four years and 183 speedline aircraft in two years. Because of safety of flight considerations, these schedules must be met; if these schedules cannot be met, then the overflow will be sent to a commercial subcontractor.

The number of aircraft on the ground at any given time also impacts the throughput. The Air Mobility Command allows only a fixed number of aircraft to be in scheduled maintenance at any given time. Therefore, lack of a backlog or queue of waiting aircraft can have a dramatic effect on the throughput by creating idle time along the critical path.

Center Wing-Box Replacement

Over multiple runs, the simulation averaged 25 aircraft throughput per year. In 90% of the runs, the required number of aircraft finished within two months of the schedule—an acceptable completion rate. The simulation indicates the proposed schedule is probably achievable. At the time of this project, only one center wing-box aircraft had been completed at the Center. It is reasonable to expect improvements in the process as the workforce becomes more proficient at this task.

Speedline

Over multiple runs of the simulation, an average of 128 aircraft were completed in two years. The goal of 183 aircraft completed in two years was never reached. Average throughput per year was estimated to be 64 aircraft. With this level of throughput, we estimated WR-ALC will fall short of its goal by 41 aircraft. This shortfall could be met by sending the unfinished aircraft to a commercial firm. The next step is to look for a way to increase the throughput, validate the improvement through simulation, and decrease the number of planes sent to a contractor.

Hangars and Manpower

Aircraft scheduled for center wing-box replacement go through a demate facility that separates the wings from the fuselage. The wings are sent to hangars for maintenance (six pairs of wings total capacity). Similarly, the fuselages are sent to hangars (six fuselages total capacity). The simulation showed that maintenance on a set of wings is completed much faster than the work on its paired fuselage. Because of these unequal rates, the position of one pair of wings could be eliminated. The position and manpower from this action could be given to either the fuselage shop or allocated to a new speedline position to increase throughput.

The simulation verified the initial estimate that the paint/depaint hangars would be bottlenecks. Eight-day delays were common waiting for the paint hangar, and delays three times this amount were common at the depaint hangar. These results underscore the need to improve the scheduling of the paint and depaint hangars.

Equipment

NDI equipment was initially identified by the Center as critical, and more equipment was being considered for purchase. The simulation indicated NDI equipment caused only minimal delay. Also, results indicated that allocation could be improved by dedicating NDI equipment to individual aircraft instead of checking out equipment as needed. Purchasing more NDI

equipment is no longer considered a desirable option, and the new allocation strategy is being investigated.

The water picking equipment was also initially considered to be critical. The simulation showed that the current equipment caused no significant delay.

Summary

The simulation model was constructed to provide the Center's management a tool to obtain a better understanding of its maintenance system. Simulation was chosen due to its capability to model complex interactions between resources and the random nature of activity durations. The model was used to determine the achievability of present aircraft throughput goals to identify bottlenecks within the system.

For aircraft throughput, the model demonstrated that, under given assumptions, speedline aircraft throughput goals could not be achieved. This information was particularly helpful because it allowed management sufficient lead time to procure additional resources or initiate action to subcontract the excess demand. However, center-wing aircraft goals were achievable. The model also identified the paint/depaint facilities as a constraint on the system and showed NDI and water picking equipment levels to be adequate for desired throughput goals. The model further identified a possible area to improve throughput by reallocating hangar space used for wing repairs from center-wing aircraft.

References

1. Goldratt, E. M., and Cox, J. *The Goal: A Process of Ongoing Improvement,* Croton-on-Hudson, New York: North River Press, Inc., 1986.
2. Haupt, Reinhard. "A Proposed Shop Management System for the Engineering Industry," *International Journal of Production Research,* 27 (1989), pp. 1053–1063.
3. Pritsker, A.A.B. *Introduction to Simulation and SLAM II,* 3d ed., New York: Halsted Press, 1986.
4. Sadeh, A., Talpazm, H., Bressler, D. A., and Griffin, W. L. "Optimization of Management Plans with Short and Long Term Problems: The Case of Shrimp Production," *European Journal of Operations Research,* 40 (1989), pp. 22–31.

Col Schuppe is Dean, School of Logistics and Acquisition Management, AFIT, Wright-Patterson AFB, Ohio; Capt McElveen is assigned to the C-141 Production Division, WR-ALC; Capt Miyares is Chief, Weapons Systems Assessments, Directorate of Supply, Air Combat Command, Langley AFB, Virginia; and Lt Harvey is an analyst, Command Analysis Group, Air Mobility Command, Scott AFB, Illinois.

Circuit Board Repair and Base Self-Sufficiency

Captain William P. Quinones, USAF

Initiatives to Repair Aircraft Parts

Facing budget cuts, organizational downsizing, and two levels of maintenance, many Air Force bases are taking advantage of initiatives to repair aircraft parts within their capability. How? By increasing their self-sufficiency to reduce aircraft parts repair costs.

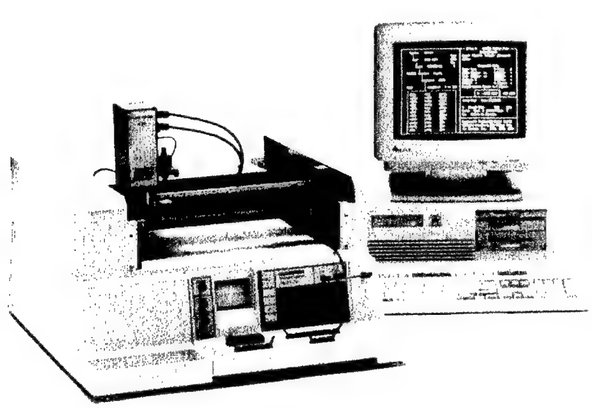
In a previous Air Force Logistics Management Agency (AFLMA) study, LM912092, *A Study of XB3 and XF3 Aircraft Parts Repair*, we reported that improvements in the reliability of commercially available "off-the-shelf" diagnostic equipment are generating intense circuit board repair interest among the bases. Maintenance supervisors believe circuit board repair offers the potential for increased self-sufficiency and reduced cost.

In a recent AFLMA study, LM922153, *Circuit Board Repair and Base Self-Sufficiency,* we explored circuit board diagnostic equipment and identified inexpensive and easy-to-use diagnostic equipment with capabilities to locate failing components on line replaceable unit (LRU) circuit boards.

Diagnostic Equipment

Huntron 5100 DS "Tracker"

Capabilities. This equipment uses the simple methodology of comparing a known good circuit board with a suspected bad circuit board to find the component. The Huntron Tracker is a computer-assisted circuit board fault identification device. It can find faulty components without power being applied to the circuit board. The system, which consists of an oscilloscope and pin-testing equipment connected to an IBM compatible PC controller, can actually be programmed to "learn" the characteristics of good circuit board components. Characteristics for a component are generated by the equipment through applying low power voltage to the component. The result is a characteristic sine wave which is stored in the computer's memory by the PC controller's software. Comparisons are made between signatures of good components and those of suspected bad components.



Huntron 5100 DS "Tracker."
(Courtesy, Huntron Instruments Company, Mill Creek, Washington)

It may take one hour to learn a circuit board with 40 components; however, the actual comparison of sine waves takes about five minutes. The tests can be accomplished using different low voltage settings. Technicians use this equipment and diagnostic data provided by automatic test equipment to locate and replace faulty board components.

Use of the Huntron Tracker, although relatively new for the Air Force, is not new to the Navy. The Naval Sea Combat Systems Engineering Station, Norfolk, Virginia, established a program office to handle circuit board repair. Their program, the Module Test and Repair Facility (MTRF), ties current automatic test equipment (ATE) and the Huntron Tracker together. MTRFs are responsible for saving the Navy several millions of dollars in LRU repair, cutting the could-not-duplicate rate by 10%, and reducing the parts causing mission capability (MICAP) impacts by 25%.

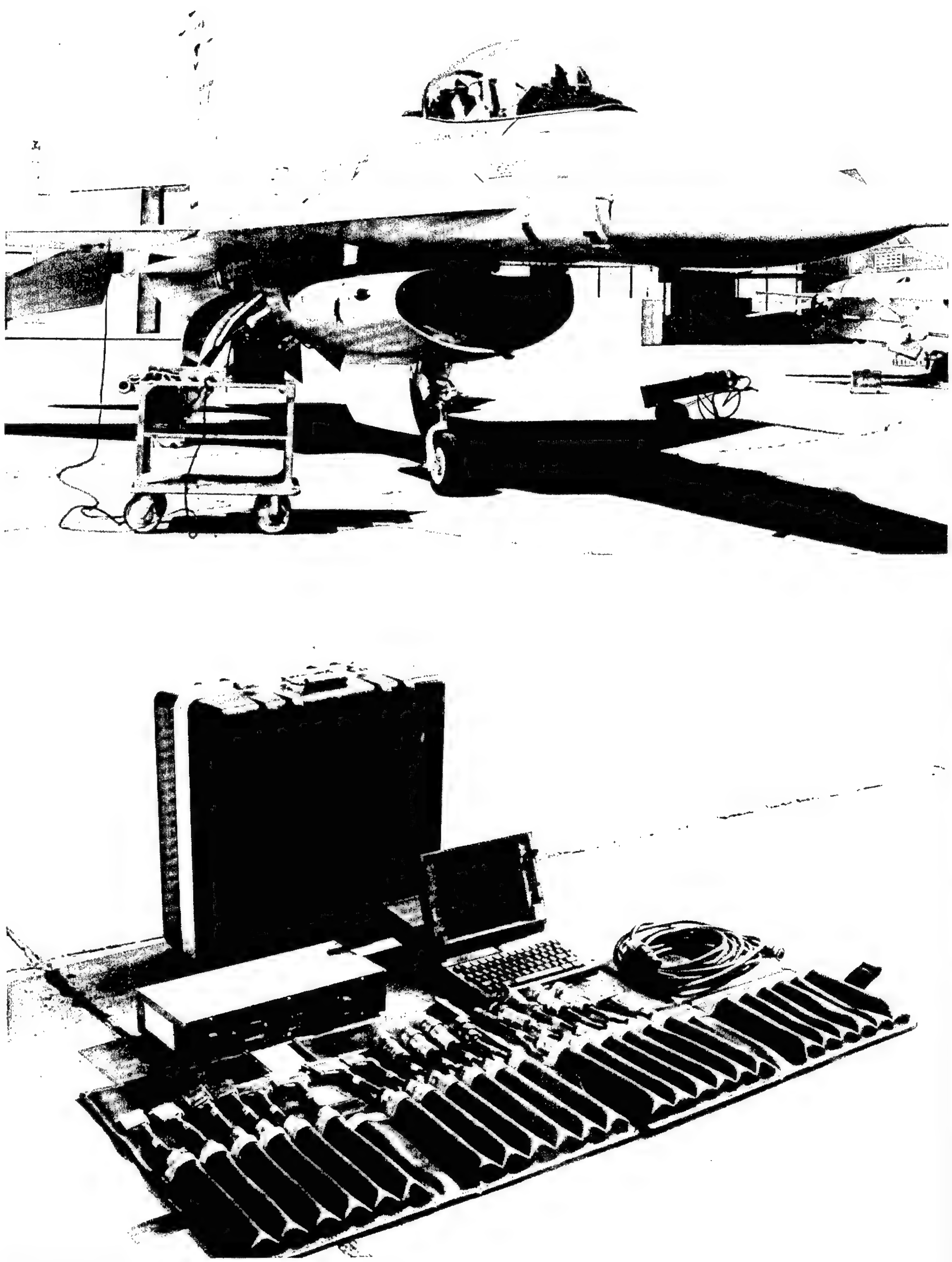
The Huntron Tracker provides a means by which skilled electronics technicians can screen shop replaceable units (SRUs) for potential board failures. It works independently of the weapon system, allowing it to be useful beyond the scope of aircraft maintenance. Useful applications involve repair of communications and computer system devices, electronic vehicle components, and medical electronic equipment.

During a visit to Moody AFB, Georgia, we looked at circuit board repair firsthand. Their technicians used the Huntron Tracker and accurately identified failed SRUs on several circuit boards. Maintenance supervisors from Moody realized a cost avoidance of approximately 200,000 dollars, from March 1992 to September 1992, as a result of circuit board repair. This cost avoidance does not include avoiding the transportation expense incurred when an LRU is shipped to a central repair source.

Training. Several maintenance organizations are now repairing circuit boards and have established strong standards for training and SRU repair procedure development. Technicians from bases performing circuit board repair have received certification training by attending 180 hours of training in microminiature repair, high reliability soldering, and multi-layer circuit board repair. This training is available through the Ogden Air Logistics Center, Hill AFB, Utah, and Warner Robins Air Logistics Center, Robins AFB, Georgia.

F-16 Multiplex Bus Fault Isolator

Capabilities. This equipment, developed for Ogden Air Logistics Center by General Dynamics, is an automated PC-based tester that isolates faults in the avionics, weapons, and display buses. It isolates faults in wires, connectors, transformers, and electronic matrix assemblies on board the F-16. It



F-16 Multiplex Bus Fault Isolator.
(Developed for Ogden ALC by General Dynamics Contract F42600-90—C-0007)

also aids in isolating broken wires, broken or bent pins, shorted wires, crossed wires, transformer resistance, and leakage failures.

Testing. The fault isolator operates in various modes depending on the test being accomplished. For instance, if a technician wants to accomplish an AC test, the fault isolator is connected to the circuit and a test signal is sent from the isolator through the transformers in the circuit, thereby giving a quick look at the complete circuit. Breaks in the circuit caused by broken wires or bent pins are detected using this test. In a DC test, transformers in a circuit are isolated and locked out. This prohibits the passage of signals through the transformers and allows the fault to be pinpointed to a specific area. In a high resistance short-to-ground test, the fault isolator sends signals through the circuit which will detect shorts in connections, wire shielding, or transformers. In an intermittent test, the fault isolator sends a continuous signal in the circuit while connectors and wires are physically shaken.

Once a particular test is completed, the fault isolator displays the expected range for the signal. The expected and actual signals are then compared. Based on the comparison, the fault isolator tells the technician whether or not the actual signal passes or fails the test. In each of these tests, power is not applied to the aircraft.

This equipment has been applied to 27 aircraft with electronic matrix or wiring problems. In each case, it reduced the troubleshooting time from 45 hours to 3 1/2 hours. The aircraft were assigned to various bases in the United States and Europe, including the Netherlands and Belgium.

Training. The avionics or weapons technician only needs one hour of training on the operation of the F-16 Multiplex Bus Fault Isolator. This training is accomplished through the program office at the Ogden Air Logistics Center.

Conclusion

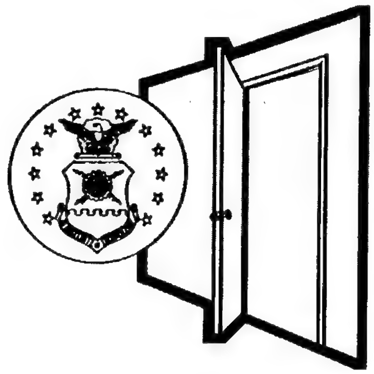
Portable test equipment, such as the Huntron Tracker and the F-16 Multiplex Bus Fault Isolator, can help the technician support the call for quality maintenance with reduced resources.

Captain Quinones is presently a Project Manager, Air Force Logistics Management Agency, Maxwell AFB, Gunter Annex, Alabama.

Best Article Written by a Junior Officer

The Executive Board of the Society of Logistics Engineers (SOLE) Chapter, Montgomery, Alabama, has selected "Redefining Before Refining: The USAF Reparable Item Pipeline" (Fall 1992), written by Captains Bradley M. Kettner, USAFR, and William M. Wheatley, USA, in collaboration with Major David K. Peterson, USAF, as the best *AFJL* article written by a junior officer(s) for FY92.

AFIT



The Doorway to Logistics Success

AFIT'S Distance Learning Initiative

Major Philip J-L Westfall, USAF
AFIT/LSE

With the reduction in personnel and funding, and with the added educational requirements recently determined by the Acquisition Professional Development Council (APDC), development of a distance learning (DL) capability has become an imperative for the Air Force Institute of Technology (AFIT), Air University's graduate and continuing education school. Using modern technological tools available to export education, such as fiber optics, digital satellite video telecommunications, computer-based instruction, computer nets, FAX machines, and the like, AFIT is developing its own 22-site DL satellite-based network, "Air Technology Network" (ATN). This network will reach all MAJCOM headquarters and Air Force Materiel Command (AFMC) logistics and product centers by mid-1993. Through well-designed, multimedia educational programs, and at a greatly reduced cost per student, AFIT will soon be reaching a much larger audience of personnel needing acquisition courses for career development. Thanks to SAF/AQ's funding support, AFIT has begun to address its continuing education backlog of over 25,000 student requirements.

AFIT's first attempt at DL was through the use of the Air Force Logistics Command's video teleconferencing network (VTCN). In October 1990, AFIT broadcast a Fiber Optics Course taught by the School of Engineering to six sites with 120 students enrolled—this was the first AFIT course to be delivered via fiber-optic link using the Defense Commercial Telecommunications Network (DCTN), the long-haul telecommunications contract for DOD. Additionally, in May 1991, AFIT very successfully broadcast its first satellite version of SYS 200, an acquisition management course taught by the School of Systems and Logistics, using a leased mobile uplink.

Coincidentally in 1991, in an effort to greatly reduce satellite transmission costs, the National Technological University (NTU), a non-profit distance education institution, secured a \$1.5M government grant to convert its analog video transmission to compressed digital video; included in this grant was the provision of a satellite uplink for AFIT. AFIT agreed to participate in the testing of this new digital system. Installation was completed in mid-March 1992. In a separate but related initiative, HQ USAF/DPC purchased NTU membership for the Air Force and installed NTU equipment at 18 sites, many of which were to be part of ATN. In June 1992, AFIT began using NTU, as a sole-source provider of compressed video, to broadcast SYS 200. NTU, however, is not on contract by the DOD and, therefore, cannot offer interoperability across the services. But AFIT is continuing to broadcast through NTU until it can use a DOD network.

Consequently, in the interest of interservice DL networking, AFIT explored interoperability issues with AT&T, the primary contractor for the DCTN. The contract provided only for fiber-optic video telecommunications with rates of digital compression that were unsatisfactory for educational use. To accommodate AFIT's requirements for a distance learning network similar to NTU, however, AT&T developed a satellite-based capability based on the NTU model. With this new DCTN-CDV (compressed digital video) service, all DOD agencies instructing via satellite can be on the same network, a very important capability for the new Defense Acquisition University, where education is to be multiservice. Moreover, because the signal uses enhanced digital compression technology, broadcasting costs have been greatly reduced over the traditional analog systems with acceptable video quality. This network is to begin at AFIT in mid-1993.

The APDC is interested in a closely integrated relationship in all distance learning projects it is sponsoring. AFIT, therefore, has tasked its contracted network developer to coordinate the ATN and NTU efforts insofar as possible. NTU and ATN will complement each other in meeting the APDC's educational needs. NTU provides, for a fee, graduate education to the Air Force acquisition community, whereas ATN is the network of choice for interservice, professional continuing education. At the suggestion of AFIT, and in the spirit of closer cooperation with DOD, NTU announced in December 1992 its decision to switch satellites and join AFIT on the AT&T system. NTU will begin broadcasting from Telstar 401, the common carrier satellite in December 1993. This merger of networks will eliminate the need for dual uplinks and downlinks, as originally planned.

In anticipation of the increased demand distance learning has placed on AFIT's resources, AFIT's commandant consolidated personnel from the various agencies associated with DL into a single organization. In February 1992, the commandant created the AFIT Center for Distance Education (CDE) and designated the School of Systems and Logistics (LS) as executive agent. The school delivers professional continuing education to meet APDC's most critical educational needs. And, with the APDC funding AFIT's DL initiative, placing the CDE under LS brings this service in-line with the customer-provider link. The CDE, nonetheless, is serving the other schools within the institute and supports Air University in the development of a command DL initiative.

AFIT's vision for meeting all of its customer demands for quality education will depend in large measure on its DL program. And, because AFIT sought a DOD solution to satellite education, AFIT's vision for the future includes merging distance learning initiatives with its sister services into a network that is more responsive both to the common defense mission and to the individual service member.

USAF Logistics Policy Insight

Accountability Codes on Quarters Furnishings Assets

The Air Force is implementing a major policy change which will change accountability codes on most quarters furnishings assets from NF-3 accountable to NF-1 nonaccountable. This initiative should allow base supply and furnishings management to save money and time, and also provide better customer service. The Headquarters Air Force Inspection Agency recommended this idea earlier this year during a Functional Management Inspection (FMI) of the Quarters Furnishings Program. The same cost-savings benefits experienced when the Air Force deleted accountability of office furniture are anticipated for quarters furniture. Past dormitory furniture accountability involved large, time-consuming custodian authorizations/custodian receipt listings (CA/CRL) for dormitory and billeting furniture located in many types of housing and billeting facilities all over a base. Base managers will still be required to keep furniture control and asset visibility by using an Air Force Form 288, Furnishings Custody Receipt and Condition Report, and by performing annual assessments of inventory and need for replacement items. Many MAJCOM supply and housing managers have hailed this move as long overdue. (Ms Katie Halvorson, AF/CEHOM, DSN 225-8182)

Publications Revamping

Ever wish you could throw out all our regulations and start over? The Air Force is revamping a large chunk of its publications system; and, while the baby is not being thrown out with the bathwater, logisticians will have a lot of learning and relearning to do. The results of a CSAF-directed comprehensive policy review will include the recision of all Air Force Regulations, replaced by fewer directives of different types. Additionally, a new numbering system is to be implemented which will parallel a proposed new numbering system for Air Force specialty codes. The CSAF wanted changes in how we formulate, articulate, and measure overarching Air Force policy. These policies will tell the field what to do, not how to do it. The field will develop the necessary procedural guidance.

Several new kinds of publications will be used, although some familiar to you, such as manuals, will be retained. Two of the new kinds of documents will be used primarily to replace the regulations we have today. The Air Force Policy Directive (AFPD) will be used to cover overarching policies for significant functional areas. AFPDs will normally be about two pages long, be prepared by the Air Staff, and contain senior officer level metrics to measure whether the policies contained in each AFPD are being successfully implemented. The Air Force Instruction (AFI) will contain the procedural guidance for consistent implementation Air Force wide and will generally be prepared by a field operating agency (FOA) or lead MAJCOM. AFIs will contain a lot of the details found in today's regulations, but AFIs will not simply be reprints of regs with a new number. Most often, a new AFI will contain the results of combining a number of old regs and reducing content to only that necessary to do the job. Each AFI must be tied to a parent AFPD; but, while there is no limit to the number of AFIs under each AFPD, one of the main goals in this whole initiative has been to reduce the amount of guidance. Both AFPDs and AFIs may have content which is legally binding.

The process of conversion has been well under way at the Air Staff level for several months, and the CSAF is personally involved in the process. By the time you read this article, many, if not most, of the new AFPDs will be on their way to the publishers and out to the field. Appropriate FOAs and MAJCOMs will have also been asked to lead the effort to develop implementing AFIs. MAJCOMs also will have been asked to begin to develop a complementary structure of their own. The resulting projected changes for logisticians are significant. From the current several hundred regulations in transportation, supply, maintenance, and logistics plans, we will go down to about 20 total AFPDs and several dozen AFIs. In a 24 Dec 92 letter to MAJCOM/CCs which included a listing of proposed AFPDs, AF/CV asked that MAJCOM functional staffs open an active dialogue on AFIs with Air Staff counterparts in order to get the AFIs moving. In fact, this process has already started. (Col Jonathan Zall, AF/LGXX, DSN 227-6939)

Air Force Policy Directive 400-3

Air Force Policy Directive 400-3 for War Reserve Materiel (WRM) has been approved by both the Air Force Policy Directive review committee and the CSAF, and submitted for publication. This concise document provides overarching policy statements as the foundation of the WRM program, establishes major functional responsibilities, and supplies a means of measurability for program fulfillment. The intent of the directive is to establish "what" needs to be done in this critical war-fighting support arena. The detailed "how to do it" instructions will be outlined in Air Force Instruction 400-301, currently being developed by USAFE/LGX. This new publication, once completed, will replace the current AFR 400-24, *War Reserve Materiel (WRM) Policy.* (Lt Col Dan Porter, AF/LGXX, DSN 227-1292, or Lt Col Dennis Putman, AF/LGXX, DSN 225-2175)

BPIE Funds

Slow obligation of funds distributed to major commands for use by bases to locally procure noncentrally managed investment equipment items (over $15,000 unit cost) threatens future funding levels. Each year the Office of the Secretary of Defense (OSD) approves, and Congress appropriates, money to support the Base Procured Investment Equipment (BPIE) program. Even though these funds are, by law, available for obligation for three years, commands need to treat them basically as an annual program. This means BPIE funds should be committed by the end of the first fiscal year and obligated not later than three months later. This approach is reasonable since money is distributed to commands based on validated current requirements (generally command requirements far exceed the funds appropriated). Failure to obligate funds within the first 15 months is perceived as an overstatement of requirements and threatens future funding levels. Bottom line—if you don't need it, don't ask for it. If you need it and ask for it, spend it. (Maj Gary Gibbs, AF/LGSP, DSN 225-7749)

Hazardous Materials and Waste

One of the greatest challenges facing installations today is the need to more actively manage hazardous materials and waste.

Air Force wide, 50% of all open Notices of Violation (NOV) issued by Environmental Protection Agency inspectors are for mismanagement of hazardous materials and waste. Until the Federal Facilities Compliance Act became law on 6 October 1992, our installations were exempt from fines and penalties resulting from these violations. Federal, state, and local environmental regulatory agencies now have the ability to levy fines and penalties for NOVs. In addition, mismanagement of hazardous materials and waste places workers at risk and exposes the Air Force to large cleanup costs if these materials are spilled.

The Pollution Prevention Program is designed to reduce our use of these materials and thus our exposure to NOVs. Under the program, installations are required to develop plans to manage and track hazardous materials purchases and hazardous waste disposal. Currently, there are many ways for hazardous materials to enter a base with no control over the process. One technique for gaining control, which is producing excellent results at test bases, is the hazardous materials pharmacy. Under this concept, all hazardous materials entering an installation pass through the pharmacy and are centrally dispensed according to actual technical orders or other requirements to use the materials. Test bases report that by actively managing hazardous materials purchases, they have dramatically reduced the amount purchased. This has reduced purchase costs, handling costs, and disposal costs. It also reduces the potential for fines and penalties from NOVs since, with less hazardous materials and waste, there is less to inspect. Since all these costs are paid from installation operation and maintenance (O&M) accounts, commanders at the test bases have realized a direct financial benefit. In addition, the Air Force Pollution Prevention Action Plan, recently signed by General McPeak, requires installations to report hazardous materials purchases and establishes a goal to reduce purchases by 50% by 1996. Hazardous materials pharmacies make gathering purchase data convenient, make reducing purchases by 50% an easy task, and save money. (Tom Russell, Air Force Center for Environmental Excellence, DSN 240-2517; Lt Col Larry Houser, AFLMA/LGM, DSN 596-4581; Adam Antwine, AF/LGMM, DSN 227-1052; Maj John Seibert, AF/SGBP, DSN 297-1735; or Capt Bill Kolakowski, AF/CEVV, DSN 297-0276)

Specialized Buying and Contract Administration

Our Air Force contracting squadrons/activities have become more involved in complex procurements requiring specialized buying and contract administration. Operational and specialized contracting squadrons/activities often retain contract administration for complex negotiated procurements which include cost-type contracts and, more recently, environmental remediation requirements.

The contract administration requirements outlined in FAR 42.302(a) for these contracts are significant. There are higher risks to the government if they are not administered appropriately. For example, on cost-type environmental remediation contracts, not only is the Air Force Administrative Contracting Office (ACO) responsible for monitoring all aspects of cost but also for reviewing various contractor systems such as estimating, compensation, purchasing, insurance and pension, and property administration. When contract administration is not formally delegated to the Defense Contract Management Command (DCMC), the contracting officer must perform these functions.

DFARS 242.203 states that DOD activities shall not retain contract administration except in specific circumstances (base, post, camp, and station purchases; construction; etc.). Retention of contract administration under cost-type contracts (including fixed price with cost-reimbursement line items), especially those not tied to the mission of the base, should be carefully examined and weighed against the retention/delegation requirements of DFARS 242.203. Unless there is an urgent or compelling need to retain administration of such contracts, DCMC should be delegated responsibility. Remember, when the Air Force retains administration of a complex contract, the purchasing office must ensure that expertise and manpower are available to provide all appropriate contract administration functions outlined in FAR 42.302(a). (Lt Col Trapper Hedges, SAF/AQCP, DSN 225-5750, or Maj Steve Smith, SAF/AQCO, DSN 224-1732)

Most Significant Article Award

The Editorial Advisory Board has selected "Logistics Management: White-Collar Cloak—Black-Magic Artistry," by Kenneth M. Gladstone, as the most significant article in the Fall 1992 issue of the *Air Force Journal of Logistics.*

Defense Business Operations Fund and Unit Cost Resourcing: A New Way of Supporting Weapon Systems

Captain Sterling K. Dugger, USAF
Captain Forrest A. Durham, USAF

This article addresses the background leading to the Defense Business Operations Fund (DBOF) and Unit Cost Resourcing (UCR) implementation and also briefly discusses the major facets of this funding mechanism. The information has been extracted from a 1992 AFIT Thesis, "An Analysis of Potential Effects of Defense Business Operations Fund Policies on Logistics Support Activities." In future articles, AFJL will provide detailed updates on how well the DBOF and UCR are working, any problems encountered, total savings, and conclusions.

The upcoming implementation of the DBOF and UCR has the potential to fundamentally change how the Department of Defense (DOD) supports its weapon systems!

DOD management is starting to change its focus from one of spending all the funds allotted to an organization to one of operating as efficiently as possible with an emphasis on cost reduction. To be successful in this new environment, DOD managers must understand the operation of the DBOF and UCR, and the effect of their actions on DBOF performance measures. The DBOF combines the revolving funds of all the Services into one DOD-wide revolving fund. Although revolving funds have been used by the military services for some time, the DBOF brings many logistics support activities, previously funded by direct appropriations, into the revolving fund. Along with the DBOF, UCR will be used to resource support functions operating under the DBOF by capturing the total cost of operating the support structure and charging the DBOF customer a fee to cover those costs.

Background

The Defense Management Review (DMR)

In his address to Congress in February 1989, President George Bush charged Secretary of Defense Richard Cheney with reviewing defense management practices and ensuring that the recommendations of the Packard Commission were implemented. The following six goals were established to guide the DMR process:

(1) Reduce overhead costs while maintaining military strength.

(2) Enhance weapon systems program performance.

(3) Reinvigorate the planning and budgeting process.

(4) Reduce micromanagement.

(5) Strengthen the defense industrial base.

(6) Improve the observance of ethical standards in government and industry. (3:9)

The Office of the Secretary of Defense (OSD) released the Defense Management Review Report on 12 July 1989. (3:8;2:22-23)

Responding to changing world realities and budget pressures, the President and Congress agreed in 1990 to a total reduction of $410 billion in the FY91-97 period. Of the total $410 billion cut, approximately $70 billion is to come from management initiatives put in place by the DMR. The DBOF is one of the prime programs that will be initiated in an effort to realize these cost-cutting goals.

The Defense Management Report Decisions (DMRDs)

The goal of the initial stage of the DMR process was to identify ways to save $30 billion during FY91-95. The result of the initial round of the DMR process was 38 approved DMRDs which projected savings of $39 billion over the FY91-95 period. The DMR process continued with round II decisions released in October 1990. (1:6-7;11)

Three of the most significant DMR management initiatives supporting weapon systems are DMRDs 901, 904, and 971. DMRD 901, "Reducing Supply System Cost," laid the foundation for unit cost development. DMRD 904, "Stock Funding of Reparables," placed Depot Level Reparables (DLR) in the Air Force Stock Fund, which will become part of the DBOF. DMRD 971, "DoD Financial Systems," expanded the customer-provider concept. (11;7:1;8:1;9:1)

Defense Management Report Decision 901

DMRD 901 addressed OSD's concern with supply system costs. This concern stemmed from the approximately $30 billion DOD spends per year to buy and manage supplies. DOD also manages an on-hand inventory of approximately $100 billion. DMRD 901 proposed the following nine initiatives aimed at reducing on-hand inventories and the cost of managing and replenishing these inventories:

(1) Move support costs funded in operation and maintenance (O&M) to the Stock Fund.

(2) Provide sufficient obligational authority to permit multiple year contracts with guaranteed minimums.

(3) Fund drawings and technical data in the Stock Fund.

(4) Allow holding and interest costs to encourage just-in-time inventory management.

(5) Authorize the procurement of forgings and castings in the Stock Fund.

(6) Provide visibility of operating and retail stocks to the wholesale inventory managers.

(7) Stock items closest to vendor rather than closest to customer.

(8) Retain returns at closest depot to reduce handling and transportation costs.

(9) Provide specific goals to managers for increasing the use of commercial items. (7:9)

With the implementation of the nine initiatives, OSD expects a 3%-per-year reduction in the cost of managing, operating, and replenishing inventories.

Defense Management Report Decision 904

DMRD 904 proposed stock funding of Air Force and Army DLRs. The main focus of stock funding DLRs was to modify behavior at the customer level by requiring the customer to pay for the support obtained. The Navy stock-funded its DLRs in the early and middle 1980s and experienced a 20% reduction in customer demand. The Air Force created the Reparable Support Division (RSD) in the Air Force Stock Fund to handle the stock funding of DLRs. (8:2;4:37-38)

Defense Management Report Decision 971

The proposal to establish the DBOF and the approval for implementation were contained in DMRD 971 (signed on 2 February 1991). The following summarizes the main intention of this decision:

> Under the financial system described, products are produced because customers want them produced and customers are able to make more intelligent decisions on the level of support required. Customers are able to trade off their limited resources between the level of support and the number of units or operating tempo to be supported. Decision makers will have better information on the cost to procure and operate weapon systems. Managers are encouraged to reduce costs, and the overall support costs of the department are significantly reduced. (9:8)

The DBOF

On 1 October 1991, DOD established the DBOF for the purpose of achieving three Defense Management Review initiatives:

(1) Consolidating like functions.

(2) Increasing cost visibility.

(3) Realizing significant monetary savings through better business practices. (5:1)

The DBOF was built on established revolving fund principles, employed a unit cost resourcing approach, and did not change any previous organizational reporting structure or command authority relationship. (5:1)

With the implementation of the DBOF, OSD wanted to send a clear message to DOD managers and Congress that it was serious about improving the performance and lowering the cost of supporting weapon systems. (9:2)

Due to significant congressional interest concerning DOD's implementation plan for the DBOF, the Statement of Managers for the National Defense Authorization Act for Fiscal Years 1992 and 1993 required DOD to release a DBOF implementation plan by 1 January 1992. The *Defense Business Operations Fund Implementation Plan,* issued on 1 January 1992, outlined DOD's approach and strategy for implementation of the DBOF. It was subsequently updated on 1 March 1992. (5:i,1-3)

The primary goal of the DBOF, as stated in the implementation plan,

> . . . is to provide a business management structure that encourages managers and employees of DoD support organizations to provide quality products or services at the lowest cost. . . . This business operations structure identifies each business area, the products or services, and the total cost of operation within that business area. (5:2)

With the DBOF, OSD endeavors to establish a market-based economic system for apportioning resources. The DBOF expands the relationship between the customer (the operational forces) and the provider (the support functions). The market-based economic system encourages DOD to operate in a more businesslike manner by focusing the operational forces on defining the requirements necessary to perform their mission and focusing the support functions on providing quality service at the lowest possible cost. (5:i,1-3)

The DBOF Resourcing Approach

Currently, support functions receive direct appropriations to provide a specific level of support for the operational forces. The support functions estimate what level of support is needed for a given weapon system and then request funding to provide that level of support. Service is provided to the operational forces at no visible cost.

Under the DBOF environment, funds will not be allocated to support functions. Funds for support will be allocated directly to the operational forces. The support functions will sell their services to the operational forces in exchange for a fee. The fee will cover the operation of the support functions, capital improvements, and the replenishment of inventories, as well as the cost of weapon systems repair services. In addition to being given the responsibility to pay the fee for services rendered, the operational forces will also be given the authority for some degree of choice in the source of support. For example, if an Air Logistics Center's performance or price is not satisfactory, the operational units will theoretically be able to choose a private contractor or another government source of supply. To operate in the new environment, support functions will have to be low-cost, responsive suppliers. (12:50-52)

Unit Cost Resourcing

Unit cost resourcing was implemented in conjunction with the DBOF in an effort to further encourage DOD support functions to operate in a more businesslike manner. (6:3-5) A goal of UCR is to have the outputs of an organization bear, as accurately as possible, the total cost of producing those outputs. To accomplish this goal, all costs incurred, regardless of funding source, are allocated to the activity's outputs. Although no savings are directly attributable to UCR, OSD believes UCR will focus managerial attention on support process cost drivers. The increased focus should induce managers to improve the processes and reduce the cost of weapon systems support. (6:4)

Under the UCR system, the unit cost (UC) of a product is calculated by taking the organization's cost of producing a product and dividing it by the total output of that product. OSD sets a UC goal for each Service or Agency level. The Service or Agency takes the UC goal imposed by OSD and allocates it to various cost centers. The UC goal may be allocated to the directorate, division, or section level.

There are two guiding rules for the allocation of UC goals. First, UC goals are allocated to the level where managers can control and be held accountable for costs. Secondly, while the goal of the directorate, division, or section may not necessarily be the same as the goal imposed by OSD, the aggregate of an activity's allocated UC goals should not exceed the UC goal imposed on the Service or Agency by OSD. (6:6-7)

Financial Performance Goals

The annual execution budget received by each support activity will provide guidance concerning the expected financial

performance. Unit cost goals will be provided for each business area. Support activity managers will be held responsible for keeping the cost of operations within the assigned unit cost goals and the customer determined workload. They will also be given the authority to make trade-off decisions for the best results. No other dollar or personnel restrictions will accompany the operating budgets. (5:6,14)

Before 1991, only the industrial funds had procedures for recovering overhead operations costs. Now, all activities within the DBOF will identify the total costs of providing a service, and prices will be established for full cost recovery. (5:2) Prices will be set on a long-term, break-even basis. According to the DBOF implementation plan:

> Profits, when they occur, are returned to customers through lower rates in subsequent years, while possible losses are recouped through increased rates in subsequent years. (5:5)

Also, managers will be given the authority and flexibility to make the trade-off decisions required to control costs and promote efficiencies. (5:2)

The Unit Cost Data Base

In order to set up the UCR system, the Services, Agencies, and OSD established task groups to define the costs and outputs of selected activities. The task groups identified the data required to track outputs and costs, and identified methods to capture the data. Once the data had been identified and the methods of data capture established, the OSD tasked the Defense Manpower Development Center (DMDC) with developing a standard UC database. In the system developed to accomplish this task, DMDC receives raw data from the support function's accounting and management systems on a monthly or quarterly basis. DMDC uses the raw data to calculate UC numbers for the support organization and provides on-line access to the UC data. (6:4-6)

Managers must use caution when making resourcing decisions using unit cost data. Specifically, they must remember that unit costs are output specific. (10:22)

A potential problem with the operation of the UCR system is the implication that all costs incurred are treated as variable costs. Although OSD acknowledged that all costs are not variable, fixed costs could not be adequately identified at that time. Treating costs as though they are all variable can cause problems in meeting UC goals if workload fluctuates significantly. Although OSD expects all activities to do their best to operate within the established UC goal, they can request an adjustment to this goal if they cannot manage within their projected earnings. (6:11-12)

Capital Budgeting

Each business area will receive a capital budget separate from the operating budget. As stated in the DBOF guidance:

> Any investment in equipment, software, minor construction, and other management improvements costing $15,000 or more is funded through the capital budget and its costs amortized or depreciated over a predetermined period. (5:16)

Congress approved a capital surcharge (traditionally less than 2% of sales) for the purpose of gradually increasing the level of capital investment in these business areas. Capital revenues are collected from capital surcharges or customer reimbursement of capital depreciation. (5:17)

Capital Depreciation

Capital assets purchased will be depreciated as an operating expense. The UCR guidance states:

> Depreciation will be calculated based on the acquisition cost less residual value. Acquisition cost will include the purchase price, plus any associated costs for transportation, installation, and other costs necessary to put the asset in the place and in the form in which it will be used. (6:14)

A depreciation cost can be treated as a direct, indirect, or general and administrative (G&A) cost depending on the location and use of the asset. (6:14) Cost savings are achieved when the payback rate of the investment exceeds the depreciation schedule; the benefits accrue to the business. In this way, capital budgeting provides incentives for managers to make investments which lead to long-term lower costs. A reduced cost to the provider means a reduced price for the customer and more effective and efficient mission accomplishment. (5:3)

Mobilization/Surge Costs

DBOF policy provides for capital budget funding of mobilization/surge requirements which would not be incurred in satisfying customer peacetime requirements. This provision allows support activities to fund requirements for wartime contingencies such as the maintenance of protective capacity, the procurement of war reserve materiel, and the purchase of excess materiel required to preserve an industrial base. Each Service or Agency will receive direct O&M appropriations to cover projected mobilization/surge costs. These costs will not be reflected in the price of goods or services. (5:18)

We hope this short article has given you a better insight of what the DBOF is all about and what it personally means to you.

References

1. Arthur, Vice Admiral Stanley R., USN Deputy Chief of Naval Operations (Logistics). "The DMR Challenge," *The Navy Supply Corps Newsletter,* 53 (September/October 1990), pp. 6-7.
2. Bowman, Mary B. "The Defense Management Review: Why This Time is Different," *National Defense,* 74 (January 1990), pp. 22-24.
3. Cheney, Richard, Secretary of Defense. "The DMR at Work: Toward Six Broad Goals," *Defense,* 90 (March-April 1990).
4. Daly, Captain Raymond T. *Development of an Executive Level Stock Fund Handbook,* MS thesis, AFIT/GLM/LSR/90S-13, School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1990 (AD-A229238).
5. Department of Defense. *Defense Business Operations Fund Implementation Plan,* Washington: DOD, 1 March 1992.
6. Department of Defense. *Unit Cost Resourcing,* Washington: DOD, 15 October 1990.
7. Department of Defense. *Reducing Supply System Costs,* Defense Management Report Decision 901, Washington: DOD, 6 November 1989.
8. Department of Defense. *Stock Funding of Reparables,* Defense Management Report Decision 904, Washington: DOD, 11 November 1989.
9. Department of Defense. *DoD Financial Systems,* Defense Management Report Decision 971, Washington: DOD, 2 February 1992.
10. Dunlap, Scott W. "A Theoretical Perspective of Unit Costing As a Resourcing Scheme," *Armed Forces Comptroller,* 36 (Spring 1991), pp. 17-22.
11. Grant, Susan J. Briefing Slides, "New Directions in Financial Management," Office of the DOD Comptroller, Washington.
12. Grier, Peter. "The Other Industrial Base," *Air Force Magazine,* 75 (July 1992), pp. 50-52.

Captain Durham is a program manager, LANTIRN SPO, Aeronautical Systems Center (ASC), Wright-Patterson AFB, Ohio. Captain Dugger is Automatic Test Equipment Program Manager, ASC/SMGB.

Career and Personnel Information

Civilian Career Management

Career Enhancement Plan (CEP)

This article highlights the Career Enhancement Plan (CEP) and its role as the cornerstone of career planning.

Effective 1 November 1992, this office implemented the Logistics Civilian Career Enhancement Program's (LCCEP) Whole Person Score (WPS). The WPS identifies the competitiveness of registrants for LCCEP promotion and career development opportunities. Earlier this year, we sent registrants an Individual WPS Report, with detailed instructions, to help them realize their full potential as logisticians. We also provided first-level supervisors with instructions so, together, they can target certain areas for development.

Of the many changes taking place within the LCCEP, none is more significant than the opportunities for career development. We urge each registrant to view career planning in very broad terms, placing equal emphasis on short- and long-term needs.

Good career planning is a joint responsibility of registrants/ supervisors. LCCEP is emphasizing those joint responsibilities and providing tools to make planning easier and more effective. These include an Individual Development Worksheet to be used in conjunction with an expanded CEP and an annual planning session with the individual supervisors, focusing on WPS elements.

The CEP is both input to, and output from, the entire planning process. It is extremely important that individuals carefully analyze what their desires and needs are before they complete their annual CEP. The place to start is with last year's CEP.

Included in the CEP is a history of developmental needs already completed and a list of the needs previously identified that are still open. First, registrants should use the open list to begin the current year's process. Next, they should determine short- and long-term career goals in terms of occupational series, levels of assignment, etc. Then, they should refer to their WPS elements and understand where there is room (and need) for growth.

Individuals should be aware that developmental needs are now broadly defined. The CEP is designed to record more than just the necessary training courses. It must now address all areas of development to include any career-broadening events, such as a move to another occupational series, another base, or another command.

Special codes, created for all training/developmental events, are listed in the Annual Training Guide. (NOTE: See Table 1 below for examples of codes.) Use them to identify specific needs to be met during specific fiscal quarter years. LCCEP will key-in on these codes when competing registrants for Air Force-wide developmental events. This process is new. If the CEP does not reflect the correct codes, registrants will not be considered for events as they become available.

Correct coding is also critical for local developmental events, which will constitute 95% of all opportunities. It is each individual's responsibility to ensure correct coding. LCCEP provides a list (Annual Training Guide) of Air Force-wide codes at the time the CEP document is generated. For local events, registrants should work with their focal point for training.

Acquisition logistics courses will be filled using CEP data. It is important to identify required acquisition courses on the CEP. Individuals should refer to the coding table accompanying their CEP so that they use current and correct codes. (Remember that codes may be added or deleted from year to year. Always use the current table.)

The bottom line is: All personnel should take responsibility for the course of their own development. They should research both available opportunities and management needs. They should also go into planning sessions with a clear vision of where

SAMPLE CEP CODES TABLE

CODE	DEVELOPMENTAL EVENT	DESCRIPTION
AAA	Seminar for New Managers	Short-Term Training
AAL	Management Development Seminar	Short-Term Training
ACS	Air Command and Staff College	Long-Term Training
AGF	Education for Public Management	Long-Term Training
BCG	Intro. to Acquisition Logistics	SYS 100
BSA	Executive Team Leadership Skills	Short-Term Training
BSG	Career Broadening	Non-Acquisition
JPA	Education with Industry	EWI
JRH	Graduate Program - University of Texas at Tyler	Long-Term Full-Time (LTFT) Training
NTU	Undergraduate Tuition Assistance	Degree Program Funds

Table 1.

their careers ought to go and a personal plan to get there. At that time, supervisors will match their desires to the projected staffing needs of the organizations. The outcome will be a new CEP, detailing the jointly-agreed-to developmental events that will implement personal career plans. (Bob Olear, AFCPMC/DPCMLR, DSN 487-5351)

Logistics Professional Development

Developing Your Own Career Path

The Officer Volunteer Assignment System (OVAS) has given officers unprecedented control of their own destiny. In "The Old System," officers waited anxiously as their assignments team passed down positions from the hallowed halls of the Air Force Military Personnel Center (AFMPC). Uncertain of even what questions to ask, they gallantly accepted the assignments and headed off to Korea, or Turkey, or wherever divine guidance might have proclaimed they should go. The guiding force was solely mission requirements, and they were relegated to a position of "passive observer" in the unfolding creation of their careers.

The OVAS has elevated each officer to an active participant. With this new-found freedom comes an awesome responsibility—officers are charged with fully understanding "the system" and putting it to work. In the past, MPC selected jobs for individuals by screening their past duties and deciding what would be their next best move, based on known paths to success. In effect, they were grooming everyone to be senior logisticians. In the OVAS, the officers and MPC share responsibilities for professional growth—they decide what they want to do in the Air Force, and MPC provides them options to get there.

The key difference between the old system and the new one is that personnel see what we see. The Electronic Bulletin Board (EBB) advertises all available openings. Once a requirement is validated with the MAJCOMs, it is added to the EBB. As in the past, officers are selected to be commanders by MAJCOMs according to lists maintained at their headquarters. Since all the cards are now on the table, the big question they should be asking is, "Which one of these jobs should I volunteer for?"

When deciding which job to volunteer for, look for the positions that satisfy professional development. Officer professional development (OPD) cannot be stressed enough. It is the key to success and continued promotion. Here at MPC we get ample opportunity to talk with senior logistics leaders who are presiding on promotion boards. A central theme they all share is that of "variety." For instance, when all variables are equal, the officers who have made the moves and garnered the added experience (strategic aircraft, tactical aircraft, ammunitions) will win out over their peers who stayed at the same base for four or five years.

The OVAS does not require individuals to move every two years because "it will look good on their record." In fact, some officers have acquired excellent OPD while stationed at a single base. The decision, like the OVAS, is a personal one. Officers should discuss their professional development with their commanders and other senior logisticians. They should try to develop a time line when they should move to get the right job. Next, they should factor into their time line family concerns, the necessity of a short and long tour, staff tours, cross-flow timing into another logistics career field, etc. Then, they should put their thoughts down on paper—it will give them a clear plan on when they should move.

Once they have developed a time line, they should decide which jobs they want to hold. We get calls all the time from lieutenants and captains who are unhappy being assistant OICs on swing shifts. We discuss a number of opportunities for them as branch OICs, but they are hesitant to commit because they do not want to move to a bomber base or out of their current command. Staying in a single command may limit their opportunity to get the good jobs.

In a recent letter to wing commanders, Lieutenant General Boles, AF/DP, wrote, "The key to advancement is breadth and depth of experience and competing for key jobs—promotions come from that, and frequently thereafter; not the other way around. Our young officers need to ask themselves a few simple questions:

What do I want to do in the Air Force?

What are my career objectives?

What do I have to do to meet these objectives?"

If their objectives are to be senior logisticians, then they must move to the good jobs. If they do not see any opportunity at their base for upward movement, maybe it is time to look for one on the EBB. Today, we have almost 400 jobs advertised in the logistics disciplines (60XX, 40XX, 66XX, 64XX, 31XX, 0046). We urge all officers to take advantage of this avenue for advancement.

(Capt John B. Cooper, HQ AFMPC/DPMRSA3, DSN 487-3556)

Mobilization as a Constraint on Operations: Applying the Theory of Constraints

Captain Christopher S. Cummins, USAF

The Air Force depends on unit level mobility to respond to unexpected events occurring over a large geographical range. If the mobilization of operational units is not timely and comprehensive, these units will fail to perform to their full potential.

This dependence on mobility is especially critical to modern military operations. As the size of the defense establishment shrinks and, with the Cold War over, forces withdraw from forward bases in Europe and the Pacific, the Air Force will rely increasingly on expeditionary forces that will deploy to a crisis location from the continental United States. (12:4-6) Timely response to crises worldwide will depend on the ability to mobilize quickly.

Applying the Theory of Constraints

One approach to evaluating the efficacy of mobilization is through application of the Theory of Constraints (TOC). TOC evaluates the performance of a process in the context of its contribution to the goals of the larger system in which it is contained. Building a system model of the mobilization process allows us to evaluate its contribution to the goals of Air Force operations. Input-output analysis is used to define the role of mobilization in the larger system.

TOC is also a method that focuses improvement efforts on those elements that limit the outputs of the system: the system constraints. The model of the mobilization process characterizes mobilization as a potential constraint on operations. Once the basic component tasks of the mobilization process are identified, approaches for maximizing the performance of the mobilization system can be suggested, including using excess capacity, stock buffers, and time buffers. The importance of prereleasing planning tasks is particularly noted.

The System Model

The reason for building a model of a unit-level mobilization system is so that the purpose and goals of mobility are made clear. Defining exactly how mobility contributes to the success of military operations is an important prerequisite to developing procedures or plans of action. The developer of TOC, Eliyahu Goldratt, put this need into perspective in *The Haystack Syndrome: Sifting Information Out of the Data Ocean*:

> Every organization is built to achieve a purpose. Thus, whenever we debate any action in any section of any organization, the only way to hold a logical discussion is by judging the impact of the action on the overall purpose of the organization. (8:10)

Looking at mobilization as a system that contributes to the success of larger objectives, such as the application of air power, is an important step to understanding how mobilization should work. (4:79-84)

Mobility and mobilization can be critical to organizational success. This is especially true in situations where an organization must be able to respond quickly to events in a large geographical area using complex, varied, and limited resources.

As an example, during Desert Storm, units moved unexpectedly and on short notice within the theater of operations. In one case, a squadron of F-16Cs moved to an airfield closer to Iraq in order to improve aircraft response time to SCUD missile sightings. The mobile SCUD missile launchers "posed one of the air campaign's most serious challenges. . . ." (6:24) F-16s in their air-to-ground role were one of the weapon systems used to find and destroy the mobile missile launchers. The threat that SCUDs posed as weapons of terror was not wholly anticipated, but was more effectively suppressed because forces could reposition quickly within the theater of operations. (14:20-29) The importance of moving forces quickly to forward operating bases to provide improved response to the SCUD threat can be translated into "lives, time, and resources saved." (7:11)

If mobility is, at times, critical to success, then procedural guidance for mobilization can improve the performance of organizations. However, before procedures can be developed, the role of mobilization in contributing to the goals of the organizations must first be clearly defined. Unit-level mobilization procedures can then be developed and judged on how well they fulfill that role.

General Systems Theory. The value of the systems approach stems largely from its ability to describe dynamic organizations. Figure 1 lists some of the important characteristics of the systems approach. Using the concepts of a hierarchy of systems (systems within systems), systems constructed of components, and input-transformation-output modeling, mobilization can be analyzed as a system within a larger environment and can also be broken down into smaller components.

Applying Inputs-Transformation-Outputs. Any attempt to use the systems approach to place unit-level mobilization into a larger environment must be based on an input-transformation-

Key Concepts of Systems Theory

Hierarchy: A basic concept in systems thinking is that of hierarchical relationships between systems. A system is composed of subsystems of a lower order and is also part of a suprasystem. Thus, there is a hierarchy of the components of the system.

Subsystems or Components: A system by definition is composed of interrelated parts or elements. This is true for all systems-mechanical, biological, or social. Every system has at least two elements, and these elements are interconnected.

Input-Transformation-Output Model: The open system can be viewed as a transformation model. In a dynamic relationship with its environment, it receives various inputs, transforms these inputs in some way, and exports outputs.

Figure 1. (11:65-66)

output model, with mobilization, since it is the focus of interest, as the transformation. Figure 2 illustrates such a model.

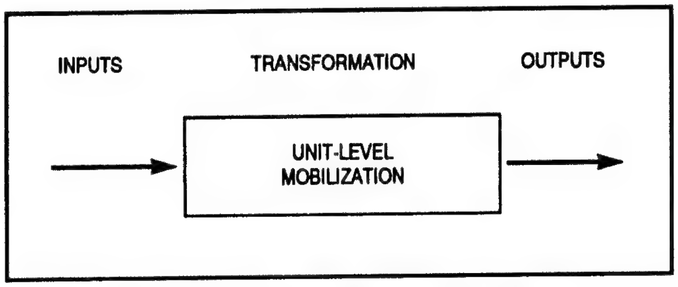


Figure 2. An Input-Transformation-Output Model.

If mobilization is the transformation, what are the inputs and outputs? United States Air Force doctrine characterizes mobility as the capability to move operating forces "anywhere in the world quickly and [to] rapidly begin operations." (4:200) Mobilization, as a subset of mobility, prepares operating forces for movement. The input to a mobility system is thus operational units.

The outputs are not as simple to identify. The result of the whole process of mobility is operation at a new location. This implies a model where the input is an operating unit, the output is an operating unit at a new location, and the transformation in between is movement.

Movement in this context is synonymous with mobility, but is not synonymous with unit-level mobilization, because mobilization entails only the preparation for the actual move. Movement implies both unit-level mobilization and transportation. Isolating the output that mobilization contributes to requires looking at transportation and mobilization as two elements within a larger movement mode.

Mobilization as a Subsystem of Movement. Figure 3 illustrates the flow from operations mode to movement mode and back again to operations mode as a unit moves from one location to another. In this representation, the movement mode consists of everything between the two operations modes, including mobilization and transportation. Within the movement mode, transportation itself is the responsibility of the carrier, usually an organization external to the unit being moved, while the conversions of a unit from operations to movement mode (mobilization) and back again from movement to operations mode (beddown) are unit responsibilities.

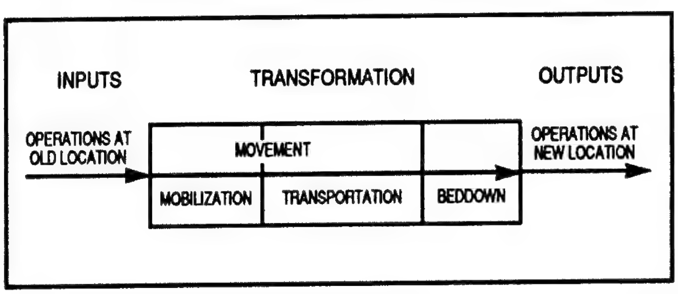


Figure 3. Progression of Operations/Movement/Operations Modes.

The focus of this paper is on the mobilization process. Figure 4 isolates mobilization as a system within a larger environment. From this model, the output of mobilization is seen as operational units that are being transported.

The Objective of Mobilization. While the immediate output of mobilization is to convert an operating unit into a unit being transported, the primary objective of mobilization is more far-reaching. The goal of mobilization is tied to the objective of

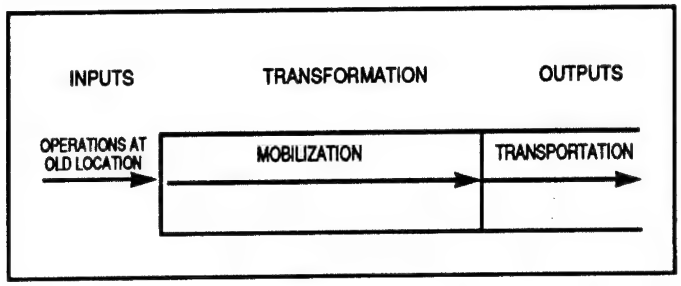


Figure 4. Progression of Operations/Mobilization/Transportation.

transportation and beddown, and to the objective of the larger concept of the movement of operational units that includes mobilization, transportation, and beddown. That goal is to allow units to operate in new locations. Operations, or the potential for operations, can define the way some organizations achieve their ultimate objective. For the Air Force, this means employing forces against an adversary. (3:1) The movement mode, considered as mobilization, transportation, and beddown combined, should facilitate operational capability.

Mobilization should facilitate operations by transforming units for transport and, particularly, should be able to transform units quickly and in a way that preserves unit operational integrity. Two passages on organizational structure, from AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force*, illustrate this point. The first says: "Speed and flexibility are required if forces are to cope with the unexpected in modern, fast-paced warfare." (3:17) This implies that time is a critical fitness-for-use parameter and that the quality of a mobilization (transforming a unit for transportation) can be judged by whether it is fast enough or not fast enough. (10:328) Mobilization should minimize the time a unit loses when it shifts from operations to movement and then back to operations. (7:13)

The second passage says: "Survivable forces must be able to sustain the fight with the proper balance of people, concepts, and equipment." (3:17) Thus, mobility should prepare forces to move so that the composition and sequencing of people and equipment preserves unit operational capability as much as possible. An example of a failure to preserve operational integrity would be moving a flight of aircraft to a new operating base without moving in the maintenance specialists, stocks of spare parts, and fuel supplies needed to keep those aircraft flying.

The purpose of mobilization is, put simply, to preserve unit operational integrity as much as possible while facilitating unit conversion from operations mode to transportation mode and to do this within certain restrictive time limits.

A Method for Continuous Improvement

Given the concept of mobilization as the link that transforms an operating unit into a transportable one, TOC becomes useful for discovering how to get the most out of the mobilization process. TOC fundamentally outlines a process of ongoing improvement within a system or organization. It is based on the premise that "every system is built for a purpose." (9:4) Every element or subsystem in that system must be judged not in isolation, but on what it contributes to the global purpose. Goldratt expands on this approach:

> How to sort out the important few from the trivial many? The key lies in the recognition of the important role of the system's constraints. A system's constraint is nothing more than what we all feel to be expressed by these words: anything that limits a system from achieving higher performance versus its goal. (9:4)

Improving system performance is accomplished using five steps (Figure 5).

The Five Steps of Focusing

1. Identify the system's constraints.
2. Decide how to exploit the system's constraints.
3. Subordinate everything else to the above decision.
4. Elevate the system's constraints.
5. If in the previous steps a constraint has been broken, go back to Step 1, but do not allow inertia to cause a system constraint.

Figure 5. (9:7)

The first step includes evaluating potential constraints to weed out trivialities. The second step means managing those elements that are truly constraints to get the most out of them. The third step is to prevent nonconstraints from wasting time, resources, and money on activities that will not contribute to the goal of the system; that is, on activities that exceed the capacity of the constraint. Since the constraint limits the performance of the system, implementing the fourth step will improve the performance of the entire system. The entire cycle of five steps is the key to continuous improvement. (9:5-7)

Mobilization as a Constraint on Operations

In the Theory of Constraints, a constraint is defined as "any element that prevents the system from achieving the goal" of the organization. (13:81) The goal of military forces in war is to "compel the adversary to do our will." (3:1) If unit-level mobilization is not quick enough or comprehensive enough to prepare a unit for transport when a wartime window of opportunity is presented, mobilization will have become a constraint on operations.

If the first step of the five TOC steps is taken and mobilization is identified as a constraint, the next step is to manage the constraint to its utmost capacity. This requires a better understanding of the nature of mobilization—of the basic tasks involved in unit-level mobilization.

The Essential Tasks of Mobilization. The next step, then, is to identify the basic tasks of mobilization. These tasks can be found by looking at two requirements: what a unit needs to do to remain operational and what a unit must do to become transportable.

In order to remain operational, a unit must know what it is meant to do (mission statement), know what assets are needed to do the job (identify manpower and equipment requirements), and be able to acquire the necessary personnel and equipment (source the required assets).

To become transportable, a unit must be able to transform those people and equipment into transportable form. Air Force Regulation 76-6, *Movement of Units in Air Force Aircraft*, lists some of the tasks that must be completed before units can be transported on USAF aircraft. This includes the physical preparation of people and equipment for transportation, the allocation of assets among available transport vehicles, and the loading of assets onto the transport vehicles. (5:1-1)

By looking at these essential tasks as a sequence of dependent events, two other essential elements become apparent and a model of the mobilization process can be derived.

Dependent Events. The tasks of mobilization are sequential and dependent. Dependent events can be defined as "operations or activities [that] cannot take place until certain other operations or activities occur." (13:52) This is the case in the mobilization process. A mission statement is a prerequisite to identification and sourcing of the required personnel and equipment. Once assets are identified and sourced, they must also be prioritized and sequenced for movement before they can be allocated to transport vehicles. This is to ensure that critical assets are moved before redundancies or trivialities. Figure 6 shows a chart used at an air base in the Middle East during Desert Storm to prioritize cargo on a daily airlift shuttle between a rear base and a forward-deployed squadron. This chart is a sample approach to sequencing and prioritizing for movement.

C-130 Shuttle
Sequence of Cargo Priority

1. Passengers and baggage.
2. Maintenance equipment and supply parts.
3. Mail.
4. Other - beds, water, unaccompanied personal items, back-up equipment, spare vehicles.

Figure 6. (2:1)

Preparation of personnel and equipment, on the other hand, is not dependent on prioritization, sequencing, or allocation, but can start as soon as the required assets have been identified and sourced. Only when assets have been both prepared for transportation and allocated to specific transport vehicles can they be marshalled (staged) for loading onto the transport vehicles. The flowchart model in Figure 7 is a representation of this sequence of events.

Planning Tasks and Physical Tasks. Logically, these essential tasks for mobilization can be divided into two types: planning

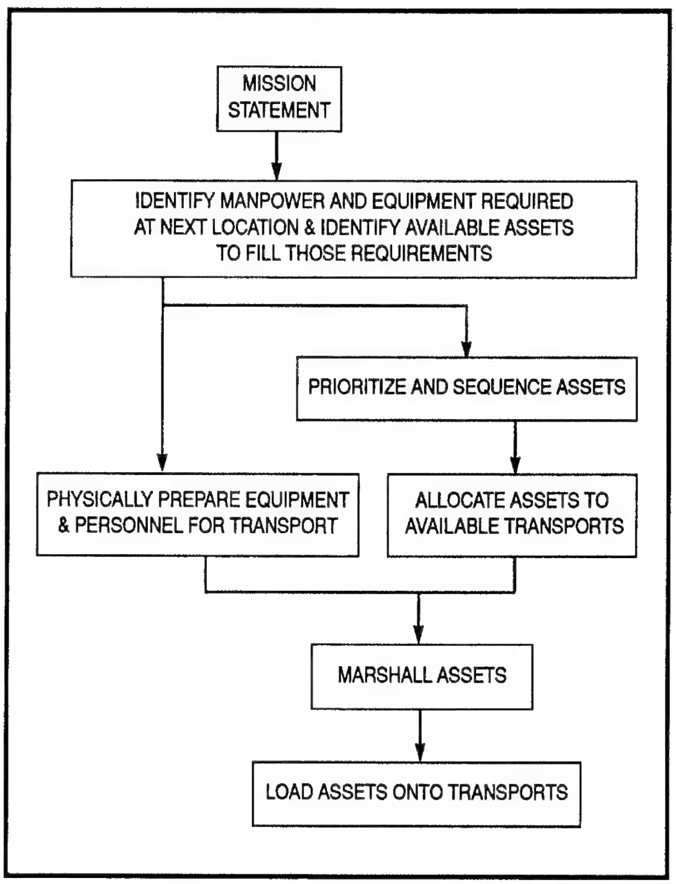


Figure 7. Sequence of Unit Tasks for Mobilization.

tasks and physical tasks. Planning tasks include the mission statement, identifying and sourcing equipment and manpower requirements, prioritizing and sequencing assets, and allocating these assets to transport vehicles. Physical tasks include the physical preparation, marshalling, and loading of assets.

Exploiting the Mobilization Constraint

Given the basic tasks involved, how can the mobilization process best be managed? In TOC the answer is management of the process flow through the use of protective excess capacity and time buffers.

TOC recognizes that any process must focus on maintaining a balanced processing flow, instead of focusing on balancing processing capacity. This is because processes are made up of dependent events, and these events each have variable processing times. Events downstream in the process are limited by the variable outputs of the events they are dependent on, so protective capacity ensures that the process flow necessary to meet demand can be maintained despite the variability of individual events. (9:138-159)

A buffer is merely a technique to ensure that as much processing capability as possible is squeezed out of a constraint. Prepositioning tasks for processing in front of a constraint ensures that the constraint always has work; that is, the constraint is never left idle and unused and the potential for higher throughput of the entire system lost. (8:121-125)

Perhaps the simplest kind of buffer is a physical stock buffer placed in front of a constraint. Another kind of buffer is one that consists purely of time. With a time buffer, jobs are released early for processing in order to buffer against the ultimate constraint, which is demand for the output of the process. Goldratt refers to this buffering against ultimate demand as a shipping buffer, since it buffers against throughput lost when "shipments" of the product are not ready to meet the demand for the product. (8:121-125)

Stock Buffers. Given the mobilization system, several alternatives exist for exploiting the constraint. The most comprehensive is to build a 100% shipping buffer. In this approach, every step in the mobilization process, from mission statement to loading onto transports, would be complete before the need for a move to another location was known. The result would be a stock buffer: an instantly transportable unit. The difficulty is, naturally, the expense involved in tying up physical resources, both operational and transportation.

The key is to balance the expense of tying up those resources with the benefits of a faster response. If the benefit from a faster move can justify the expense of maintaining both mobility assets, ready to go, and training assets, then this would be the best approach to take.

Time Buffers. An approach that does not tie up operating forces is to prerelease as much of the planning tasks as possible. This will not affect the operation of physical assets in that it is "off-line" and will reduce the mobilization process to the physical tasks when the time to move arrives. However, expenses exist for this approach as well—those related to maintaining a continuous planning process. Since our ability to forecast requirements for the future is most effective in the short run, plans must be continuously updated and revised to remain effective; and we must try to account for all significant possible events. This might include planning for situations that call for different operational capabilities, for different transportation modes, and so on.

Which Approach to Take? True physical constraints on a process are rare. Most constraints are logistical/policy constraints that result from inadequate planning and control mechanisms. (8:62-63) This implies that the limiting factors in mobilization are the planning tasks, not the physical tasks. Once the planning tasks have been accomplished, the physical tasks can be completed relatively quickly.

Oil industry experts, commenting on the inadequate initial containment response to the Exxon Valdez spill, recognized that the failure was largely due to a failure in planning:

> Planning and response go hand-in-hand because without advance preparation, no amount of expertise, manpower, or equipment can be effectively organized on the spot in the chaotic situation which prevails after a large spill. (1:41)

Focusing on the planning tasks prior to actual mobilization is more likely to result in a faster, more productive mobilization process.

The Other Steps. Often the process of exploiting a constraint will reveal planning and control problems, or in other words, reveal a policy constraint. (8:62-63) Failure to prerelease planning tasks is an example of a policy constraint. Once a policy constraint is identified, it should be immediately elevated. There is no sense in devoting energy, resources, and time to exploiting a constraint and subordinating an entire system if that constraint is the result of faulty rules. Faulty rules should simply be changed. (8:130) Regardless, once mobilization is elevated, the new constraint, whether it is transportation capability, operational capability, or something else, becomes the new focus for improvement of the organization.

Focusing on the core problem, the constraint, as well as refusing to let inertia take control of the organization, is the key to continuous improvement. (9:7)

Conclusion

As stated, the purpose of mobilization is to quickly transform operating units into transportable units while preserving operational integrity. Given this purpose, mobilization can be defined as a potential constraint on operations. Getting the most out of that constraint means looking at the mobilization process itself for means of improvement. The mobilization process consists of certain sequential and dependent tasks which can be categorized as either planning tasks or physical tasks.

Application of the Theory of Constraints suggests that prereleasing those planning tasks—that is accomplishing those planning tasks before demand for actual mobilization exists—is the key to elevating mobilization as a constraint on operations.

References

1. Anderson, Charles B., and Starer, Brian D. "Contingency Planning Crucial to Oil-Spill Response," *Oil & Gas Journal*, 35 (5 March 1990), pp. 41-46.
2. Cummins, Captain Christopher S., Installation Mobility Officer. Memorandum for Record, 388th Tactical Fighter Wing (Provisional), Al Minhad Air Base, United Arab Emirates, 9 February 1991.
3. AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force*, Vol I, Washington: HQ USAF, March 1992.
4. AFM 1-1, Vol II, Washington: HQ USAF, March 1992.
5. AFR 76-6, *Movement of Units in Air Force Aircraft,* Washington: HQ USAF, 29 September 1978.
6. Department of the Air Force Report, *Reaching Globally, Reaching Powerfully: the United States Air Force in the Gulf War,* Washington: HQ USAF, September 1991.

(Continued on page 40)

Current Research

Air Force Armstrong Laboratory Logistics R&D Program

The Logistics Research Division of the Armstrong Laboratory performs research and development (R&D) focused on technology for improving the performance of integrated systems of people, information, and equipment doing essential acquisition and logistics support functions in peacetime and wartime. This includes developing automated job aids and integrated diagnostics for maintenance information trade-off techniques and design tools for integrated product development that allows consideration of weapon system supportability and maintainability from design inception. Applications cover a broad spectrum of field, depot, and space operations with "customers" throughout the Air Force, Department of Defense (DOD), other government agencies, academic institutions, and US industry.

The text that follows contains brief descriptions of selected ongoing programs within this Division and is current as of January 1993. Readers interested in obtaining more information about these programs, future plans, or additional details about the Division are encouraged to call the individuals named for each work effort.

REQUIREMENTS ANALYSIS PROCESS IN DESIGN FOR WEAPON SYSTEMS (RAPID)

OBJECTIVE: To define, analyze, and manage weapon system requirements as an integral part of the systems engineering model of acquisition.

APPROACH: RAPID's three-phase approach includes 12 months of evaluation and decision-making, 13 months of implementation and initial demonstration, and 13 months investigating extensions such as expert system technology and integration with other analytical tools used by development and mission planners. Phase I is a period of critical design: determining RAPID user needs and concept of operations, examining open system issues and evaluating the utility of off-the-shelf software, determining a basic hardware/software platform, and arranging field demonstrations. Phase II is oriented to coding, testing, and user validation of both the concept and the software. Phase III will see the users heavily involved in conducting a demonstration and recommending extensions to the basic capability. Ongoing related efforts are Acquisition Logistics Team Applications, an Armstrong Laboratory in-house effort, and the Systems Engineering model under development by the Air Force Materiel Command (AFMC).

EXPECTED PAYOFF: RAPID offers the potential of reducing both manpower costs and contractual analytic costs through the standardization and reuse of critical acquisition data. This software application offers operational users, designers, and the acquisition corps iterative and effective use of requirements oriented data to support the earliest phases of acquisition. (Ms Janet L. Peasant, AL/HRGA, DSN 785-8502, (513) 255-8502)

INFORMATION INTEGRATION FOR CONCURRENT ENGINEERING (IICE)

OBJECTIVE: To develop technologies critical to effectively manage information resources in support of Concurrent Engineering.

APPROACH: With this understanding, the program is building solutions for a new era of challenge. Using the Concurrent Engineering environment as a representative example of the challenge facing both DOD and industry, the IICE program is developing technologies to effectively manage information resources, through a balance of experimental and theoretical work.

EXPECTED PAYOFF: Taken together, the IICE program is targeted at providing the tools and engineering foundations for renewed American competitiveness. The resulting products will provide strategic and tactical planners with reliable roadmaps for change, and users with systems that serve their needs. (Captain JoAnn M. Sartor, AL/HRGA, DSN 785-7775, (513) 255-7775)

RELIABILITY, AVAILABILITY, AND MAINTAINABILITY IN COMPUTER-AIDED DESIGN (RAMCAD)

OBJECTIVE: To facilitate the seamless incorporation of reliability, maintainability, and supportability (RM&S) analysis early into the design process using a fully integrated computer-aided design and engineering (CAD/CAE) environment.

APPROACH: This advanced development work is jointly funded by AL/HRG and the Army Armament Research, Development and Engineering (RD&E) Center. RAMCAD incorporates commercially available software packages with CAD/CAE software to perform RM&S analysis on various CAD workstations for electrical, mechanical, and structural design. The RAMCAD system brings RM&S issues to the heart of the design trade-off process by taking RM&S analysis directly to the designer. These capabilities enable the designer to review RM&S requirements, predict RM&S characteristics for a candidate design, and compare the results with the requirements. There will be several demonstrations at Oklahoma City Air Logistics Center to show the capability of RAMCAD to redesign existing systems.

EXPECTED PAYOFF: RM&S analysis is done earlier and more efficiently resulting in fewer Engineering Change Proposals and more reliable and maintainable weapon systems. For example, a $1.5M savings was realized for one single cruise missile subsystem, and a $500K savings was realized from the early identification of two design flaws before prototype development in a second subsystem. (Mr James C. McManus, AL/HRGA, DSN 785-8049, (513) 255-8049)

DESIGN EVALUATION FOR PERSONNEL, TRAINING AND HUMAN FACTORS (DEPTH)

OBJECTIVE: To accurately portray work requirements for equipment maintenance through computer-graphics simulation. Provide CAD-based design tools to allow human performance to be visualized during design evaluation for improved maintainability of new and/or modified systems.

APPROACH: DEPTH is an Advanced Development contract with Hughes Missile Systems (formerly General Dynamics Convair) with subcontracts with the University of Pennsylvania for human modeling and Operational Technologies, Inc., for hazardous material information for human task analysis. There is a Memorandum of Agreement in coordination with NASA Ames and the US Army Research and Development Laboratory on human figure modeling. DEPTH work is also supported by the Crew Chief program and by other branch work on human/system integration through more powerful task analysis methods known as Comparative Anatomy of Maintenance Tasks. It is also supported by separate research at Pennsylvania aimed at

creation of natural language interfaces for animation control. DEPTH will also contribute to the Manpower, Personnel, Training Decision Support System (MPT/DSS) of AL/HRM by providing task analysis documentation in support of work force planning and costing, among other needs. Beta tests are planned for General Electric and Oklahoma City Air Logistics Center beginning Fall 1993 and continuing at other sites throughout the contract.

EXPECTED PAYOFF: Cost avoidance in human resources through better job design using DEPTH is about $1.2 million annually (constant 1992 dollars) for deployed wing of F-15s and F-16s. (Mr Edward S. Boyle, AL/HRGA, DSN 785-5169, (513) 255-5169)

COMPARATIVE ANATOMY OF MAINTENANCE TASK (CAMT)

OBJECTIVE: To predict human performance and resource requirements for maintenance of proposed subsystem designs.

APPROACH: CAMT decomposes all maintenance tasks within a maintenance domain (such as aircraft engine repair) into common pieces, called "primitives." Through extensive data collection with subject matter experts, real-world data regarding the human requirements of each primitive are collected for multiple applications (on diverse designs) and stored in a database for future access. When presented a proposed new design and a list of maintenance tasks, the human factors analyst may then decompose the new tasks into constituent primitives, access the real-world consequences of older designs on these primitives, extrapolate to the anticipated consequences of the new design, and sum the anticipated consequences for all maintenance on the new design as a cost/benefit measure. In contrast to traditional comparability studies, the CAMT analyst extrapolates from old human requirements to new at a detailed level of user tasking applying multiple design baselines. Quantitative predictions or design consequences via CAMT give weight to human factors recommendations.

EXPECTED PAYOFF: CAMT would be the first Air Force tool to perform Human Systems Integration (HSI) as defined by DOD Directive 5000.2 CAMT will enable analysts to better articulate not only how to optimize user-system interaction for maintenance, but why. (Captain Donald R. Loose, AL/HRGA, DSN 785-3871,(513) 255-3871)

OPERABILITY ASSESSMENT SYSTEM FOR INTEGRATED SIMULTANEOUS ENGINEERING (OASIS)

OBJECTIVE: To develop and demonstrate a simultaneous engineering methodology which provides operation users and system designers with a common paradigm for identifying, evaluating, and reducing operability issues throughout the life cycle of complex weapon systems. Provide tools and techniques for users and engineers to: (1) identify high operator/crew task demands, (2) optimize human/system performance, (3) evaluate crew size/composition, and (4) conduct man/machine functional allocation trade-offs.

APPROACH: Conceptually, this advanced development program is a toolbox analysts can employ to investigate operability issues. The toolbox contains requirements definition tools, rapid prototyping tools, system emulation libraries, behavioral models, human-in-loop simulation tools, and data collection and analysis tools. All modules are designed to be usable by noncomputer scientists. The tools and models are integrated through a modular software framework that allows an analyst to "plug in" needed modules. A unique aspect of OASIS is when emulating a multi-crew environment, OASIS can provide either crew stations for each operator or artificially intelligent human operator models capable of operating the individual crew stations. The model would serve as additional crew members during human-in-loop analysis of the design.

EXPECTED PAYOFF: OASIS supports designers in determining the right mix of automation and allocation of function and crew sizing, while reducing usability problems. The benefits of such analytic capabilities include more effective and efficient systems designs, fewer retrofits to correct design deficiencies, and increased user acceptance of new and/or modified systems. (Captain Kevin L. Formolo, AL/HRGA, DSN 785-8340, (513) 255-8340)

SYSTEM CONCEPT OF OPERATIONS EVALUATOR (SCOPE)

OBJECTIVE: To optimize the design of information dense, time critical systems (such as command, control and communication (C3)) by modeling, simulating, and analyzing their high level operations. Parameters, such as floor layout, crew size, crew composition, communication flows, and automation impacts, can be tested and traded off on the computer well before the system operational concepts are frozen and hard mockups are developed.

APPROACH: SCOPE is an exploratory development program. It is jointly managed by AL/HRG and the Naval Undersea Warfare Center (NUWC). AL/HRG has the lead in funding and defining technical direction. In order to achieve the program objective, SCOPE is being field-tested at NORAD and the US Space Command (N/SP) in Colorado Springs, Colorado. The tool is being used by operational and contractor personnel to build a model of the NORAD Command Center (NCC). Their ultimate goal is to use a finished SCOPE product in future consolidation efforts involving the NCC and US Space Command Center. While the tool is only through 50% of its development life, users are given periodic software updates to utilize the SCOPE features that are available.

EXPECTED PAYOFF: Program cost and schedule savings when computer evaluation is done early in the acquisition process, rather than after hardware procurement. (Captain David A. Hathaway, AL/HRGA, DSN 785-9945, (513) 255-9945)

ADVANCED GRAPHICS FOR INTERACTIVE ELECTRONIC PORTABLE DISPLAY

OBJECTIVE: To develop techniques to more effectively use graphics to present technical information for maintenance on automated technical data systems, and develop techniques to reduce the cost of graphics for use with Interactive Electronic Technical Manuals (IETMs). Specific goals include creating authoring guidelines for graphics for IETMs and developing more effective ways to present large, complex graphics on small portable electronic displays.

APPROACH: This effort has two phases. Phase I is a one-year task starting in FY93 to conduct preliminary research to identify the types of graphics to be displayed, how they should be displayed, and evaluate the application of IETM compliance toward the development of authoring guidelines and new innovative presentation techniques. Phase II will be a two-year effort to further develop the more significant areas identified in Phase I. During the entire effort, some data collection and demonstrations of different graphics techniques will be conducted with maintenance technicians to gather their reactions to various alternatives.

EXPECTED PAYOFF: Improved performance of maintenance technicians using electronic technical data and reduced cost of acquiring these (IETM compliant) data. This

effort will also provide better illustrations and graphics to technicians through new innovative techniques. (Mr Brian C. Smith, AL/HRGO, DSN 785-2606, (513) 255-2606)

AIRCRAFT BATTLE DAMAGE ASSESSMENT AND REPAIR TECHNOLOGY (ABDA/R)

OBJECTIVE: To enhance deployed Air Force aircraft battle damage assessment/repair (ABDA/R) capability by providing the battle damage assessors with an automated aid which provides ready access to all information required to evaluate battle damage.

APPROACH: A contracted research effort will start in late 1993 and will be accomplished in three major phases. Phase I, an analysis of the ABDA/R process, and recent ABDA/R experience will identify: specific ABDA/R information requirements; ways in which Integrated Maintenance Information System (IMIS) information, storage, and presentation procedures can be supplemented to better support the ABDA/R process; and required new ABDA/R aiding requirements/capabilities. Phase II will develop and demonstrate the requirements identified in Phase I. Phase III will test these new ABDA/R capabilities on a section of a testbed aircraft. A follow-on effort will evaluate the expanded IMIS as an assessment aid. IMIS methodology to support this approach will include trade studies; interviews; data collection; software-intensive programming of algorithms and process/event schema; and data authoring for the targeted weapon system.

EXPECTED PAYOFFS: Fast and accurate battle damage assessment and repair information, improved deployment capabilities, and improved combat effectiveness. (First Lieutenant Eric N. Carlson, AL/HRGO, DSN 785-6718, (513) 255-6718)

INTEGRATED TECHNICAL INFORMATION FOR THE AIR LOGISTICS CENTER (ITI-ALC)

OBJECTIVE: To improve, standardize, and integrate technical and management information; and to make it more readily available at the job to improve the process of ALC aircraft maintenance and support operations.

APPROACH: This effort has two phases. Phase I will involve a complete requirements analysis of aircraft maintenance operations at a selected ALC. This work will build on the work completed in determining flight-line requirements, during the IMIS project. Phase II will use the results of the requirements analysis to design, develop, and test a demonstration depot-level integrated maintenance information capability.

EXPECTED PAYOFF: Improved efficiency, lower operating costs, and improved technician performance at Air Logistics Centers. (Ms Barbara L. Masquelier, AL/HRGO, DSN 785-2606, (513) 255-2606)

INTEGRATED MAINTENANCE INFORMATION SYSTEM (IMIS)

OBJECTIVE: To improve Air Force maintenance by providing maintenance technicians with an integrated information system capable of providing technicians with a single source for all information required to do the job. Develop and demonstrate an automated system to integrate and deliver automated maintenance information from various sources to the flight-line technician.

APPROACH: This program has four phases. Phase I, information modeling techniques (Integration DEFinition (IDEF)) were used to identify maintenance information requirements; Phase II, basic system design was developed; Phase III, system fabrication is being accomplished; and Phase IV, the system field test will be accomplished. State-of-the-art, object oriented software technologies are being used for developing the IMIS. The portable maintenance aid is a special design composed of off-the-shelf modules. This program is being worked jointly with the F-16 System Program Office.

EXPECTED PAYOFF: Estimated savings are in the hundreds of millions of dollars for both operational commands and depots organizations. This technology will reduce the number of false removals, reduce the database size, and ultimately reduce the amount of aircraft downtime. (Mr Richard E. Weimer, AL/HRGO, DSN 785-3871, (513) 255-3871)

NEXT GENERATION LOGISTICS SIMULATION (NGLS)

OBJECTIVE: To demonstrate an advanced logistics planning tool which utilizes state-of-the-art simulation software technologies and artificial intelligence methodologies.

APPROACH: This exploratory development program will take a technologically aggressive approach to the development of the advanced logistics planning tool by pushing the limits of simulation technology. The goal will be to demonstrate advanced planning tools to USAF logisticians at the Air Combat Command. Close coordination with operational logisticians will be very important throughout each stage of the project. Since the NGLS is considered technologically aggressive, plans for a field test of the demonstration planning tool will not be considered until the feasibility of the concept has been proven.

EXPECTED PAYOFF: Deployments of wing and squadron level resources will be more successful because NGLS will allow quicker and more accurate simulations of logistics plans. The ability of NGLS to quickly replan to meet unexpected requirements will be a significant addition to Air Force logistics simulation capabilities. Finally, the ability of local logistics experts to fully exercise NGLS capabilities will increase accuracy and reduce costs of wing/squadron level logistics simulations. Similar benefits will be realized for Command and Air Staff level deployment planning and capability assessments. (Captain Bradley A. Lloyd, AL/HRGO, DSN 785-3871, (513) 255-3871)

INTEGRATED MODEL DEVELOPMENT ENVIRONMENT (IMDE)

OBJECTIVE: To improve the quantity, quality, and timeliness of information based on logistics simulations.

APPROACH: Using commands have ongoing initiatives which are investigating ways of improving their simulation capabilities; however, these programs have taken an incremental approach. This project has taken a much more aggressive approach. State-of-the-art data management, user interface, and modeling methodologies are being incorporated into the IMDE prototype. The goal is to "leap ahead" and demonstrate simulation capabilities far beyond what is currently available. US Navy and US Air Force organizations which utilize simulation in decision support studies, as well as AL scientists, will evaluate the utility of the IMDE tool.

EXPECTED PAYOFF: Easier-to-use modeling and simulation software tools that will shorten the time necessary to develop analytic models. (Captain Bradley A. Lloyd, AL/HRGO, DSN 785-3871,(513) 255-3871)

READER EXCHANGE

The following letters are in response to articles published in the Fall 1992 issue of the Journal.

Dear Editor

Jerry Peppers is right! As the primary author and advocate of AFM 10-1, I, too, was disappointed that our Air Force institution could not embrace the term *logistics* as the best descriptor of those combat service support activities that create and sustain aerospace power. But we have not given up. The Air Staff is again poised to update its logistics doctrine. However, I am not sanguine about whether we can significantly improve or amplify our doctrine beyond the precepts of AFM 10-1. (And let's face it, Jerry, if a one-for-one replacement of the words *combat support* were made with the word *logistics*, then virtually all of your criticism would dissipate since the logistics concepts of AFM 10-1 are largely immutable given its level of abstraction. Moreover, with Congress and OSD now heavily engaged in the professional development of wholesale logisticians, the term *acquisition* might be forced upon the Air Force community in place of *logistics*. Words are important and, yes, AFM 10-1 is better than "nothing" and, most certainly, better than its 1968 predecessor.)

But the real issue is the indoctrination of our military and civilian heirs whom we must prepare to meet the logistical challenges of the future. We need to go beyond the basic doctrine of AFM 10-1 to develop operational-level and tactical-level doctrine that can be applied to all our resources—people, materiel, facilities, information, and time—so our logistics processes can produce the maximum combat power.

Finally, I would encourage all logisticians, retired and active, to put pen to paper and give us "lessons learned." I would be happy to act as a conduit—unfiltered—to the Air Staff as we begin to formulate our doctrine during the new year. Address your correspondence to HQ AFMC/XPX, Wright-Patterson AFB OH 45433 or call me at 513-257-6101 or DSN 787-6101.

Colonel William T. McDaniel, Jr., USAF
Director of Plans, DCS/Plans and Programs
Headquarters Air Force Materiel Command
Wright-Patterson AFB, Ohio

Dear Editor

I commend and thank Colonel Kenneth Faulhaber, USAF, for his fine account of the Clark Air Base supply closure. As a former "Ash Warrior" and the chief of supply referred to in the article, I can attest to the accuracy of his description of what happened. Racing against an extremely compressed drawdown schedule and ever-present danger, our small group of suppliers and augmenting RADS specialists rose above the stress and miserable conditions to accomplish the seemingly impossible. They, along with their transportation counterparts (who were also RADS-augmented), played a pivotal role in the timely, dignified, and fully successful withdrawal of US forces from this historic and once-prominent installation. I speak for all of them in expressing my gratitude for Colonel Faulhaber's article, as well as for the great support that he and the Pacific Air Forces staff provided throughout the ordeal.

Colonel Stephen R. Miller, USAF
Commander, 834th Logistics Group
Hurlburt Field, Florida

US Army Fields TED, Making Visual Expert Systems A Reality

The US Army Research Laboratory and the Knowledge Engineering Group of the US Army Ordnance Center and School announced the successful development of a visual expert system for diagnostics of the M-1 tank's turbine engine. TED (Turbine Engine Diagnostics) was developed using Symbologic Adept for Windows, a visual, procedure-based expert system tool from Symbologic Corporation. The application, currently delivered on a color laptop PC one support level behind the front lines, is headed for extensive field work this spring.

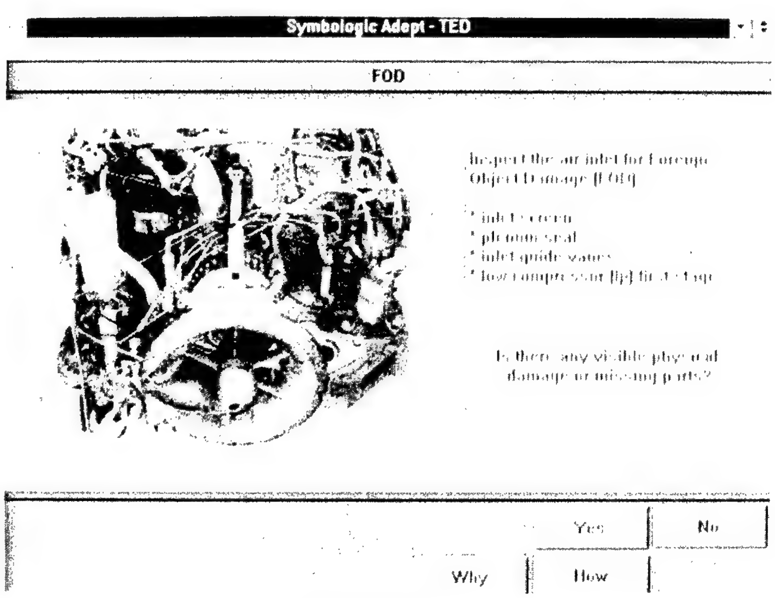
Pictures of the engine and graphical representations of the diagnostic process prompt novice and experienced Army mechanics for input or action as they are guided by TED through the correct maintenance procedures. The mechanic can retrieve additional information such as diagnostic hints or text manuals by clicking on specific areas of an engine photograph or a help button. Additionally, a device called the Automatic Breakout Box (ABOB) transmits data from sensor catch points on the engine to the program. Based on analysis of the data, TED suggests the next possible course of action to the mechanic. After successful diagnosis, TED guides the mechanic through the appropriate repairs. The application also orders the correct parts and prints the paperwork for the process.

The Ordnance Corps is responsible for managing the entire maintenance mission for tanks, trucks, missiles, electronics, and artillery for the US Army. TED is aimed at increasing the accuracy of the maintenance process and decreasing costs. Major Orlando Illi, Chief of the Knowledge Engineering Group, US Army Ordnance School, commented: "TED is a very important step. The use of visual expert systems is making possible our mission to automate the millions of procedures necessary for improving the effectiveness of our maintenance staff. Our use of visual expert systems is also allowing us to distribute valuable knowledge throughout the Army and decrease training time."

The US Army's selection of Symbologic Adept grew out of an extensive evaluation of expert system tools. Dr Richard Helfman, US Army Research Lab, said: "Adept's procedural-based approach is very natural to troubleshooting and diagnostics, but it was Adept's ease of use, visual user interface and price performance that won it the job. Symbologic Corporation was also very willing to work with us on customizations."

The US Army currently has Symbologic Corporation under contract to enhance Symbologic Adept for the next generation of maintenance applications. These applications will reside on industry standard PCs that can be attached to the mechanic's belt or helmet, freeing them from the physical limitation of the laptop PC. These applications will also take advantage of emerging technologies like voice and video.

Steven Klock
Product Manager, Symbologic Adept
Symbologic Corporation
Redmond WA



Screen shot of TED.

This paper, the third of four military logistics articles, discusses the Vietnam War and its historical significance.

History of US Military Logistics—Vietnam War

Captain Jack E. King, Jr., USAF

Part III

Vietnam War

Although US "advisors" were in-place, war was not expected in Vietnam. Once again Americans were caught unaware. Logistics planning for the Pacific theater was inept, and no deployable logistics force/system capable of sustaining combat existed. Available ports and airfields were inadequate. The in-country infrastructure was no better than that experienced in the Korean War—primitive, at best. Finally, no logistics troops were in-country. (5:6)

Both the Korean War and the Vietnam War taught strategists many things; yet, logistics lessons learned in the Korean War failed to be properly implemented. Because of its unsuccessful outcome, it is more important than ever to understand the lessons of US involvement in the Vietnam War and their application to today's combat readiness. The US philosopher, George Santayana, said:

> Progress, far from consisting in change, depends on retentiveness. When change is absolute, there remains no being to improve and no direction is set for possible improvement; and when experience is not retained, as among savages, infancy is perpetual. Those who cannot remember the past are condemned to repeat it. (10:284)

What began as a very limited effort to check communist expansion in South Vietnam ended a decade later with more than 200,000 American soldiers killed or wounded. US involvement in Vietnam began during the administration of Dwight D. Eisenhower (1953-1961). Vietnam, a former French colony, had been partitioned in 1954 into a communist-dominated regime in the north and an anticommunist regime in the south. North Vietnam, under the leadership of the skilled guerrilla fighter, Ho Chi Minh, was lending military support to a group of communist insurgents in the south who were attempting to overthrow the South Vietnamese government. Under Eisenhower, several hundred military advisors were sent, along with economic aid, to strengthen the forces of anticommunism. As the insurgency began making consequential inroads, however, Eisenhower's successor, John F. Kennedy (1961-1963), decided to commit American support troops to South Vietnam. Four thousand troops were sent in 1962. Under President Lyndon B. Johnson (1963-1968), events in South Vietnam began to move swiftly. US intervention mushroomed both militarily and politically. In 1965, US air strikes were ordered against North Vietnam. By 1965, such air strikes became part and parcel to daily activities of those stationed in Vietnam. In 1966, more than 200,000 troops were committed to Vietnam.

Surprises. Initially, most Americans backed Washington's Vietnam policy. Government reports depicted the Viet Cong (the name given the communist insurgents) as a communist guerrilla movement which employed terror and coercion to force the hapless peasantry of South Vietnam into submission. Moreover, the North Vietnamese, who were underwriting the efforts of the Viet Cong with troops and armaments, were receiving a steady supply of war materials and monies from communist-bloc nations, especially the People's Republic of China. A dangerous situation seemed to be developing, one which the US government referred to as the "domino theory"—if South Vietnam were allowed to fall to communism, so eventually would the rest of Southeast Asia. Given these circumstances, aiding the government of South Vietnam appeared both honorable and consistent with America's best interests. But as the war dragged on and a military victory appeared more and more elusive, these arguments were rapidly becoming moot. Much weightier arguments were evolving; namely, the cost in American and

Figure 1. Vietnam (1:12)

Vietnamese lives and in American dollars. Americans began questioning the credibility of those factors allegedly motivating their government's involvement.

The American effort in Vietnam was the best modern military science could offer. The array of sophisticated weapons used against the enemy boggles the mind. Combat units applied massive firepower with great precision using the most advanced scientific methods. Military and civilian managers employed the most advanced techniques of management science to support combat units in the field. The result was an almost unbroken series of American victories—victories that somehow became irrelevant to the war. After all, how can a nation win every battle and yet lose the war? In the end, the best military science had to offer was somehow not good enough—and thus the paradox: politics and popular impressions defined a failure.

Predictably, Vietnam became the primary focus of attention during the presidential election of 1968. In an apparent effort to induce the North Vietnamese to join the US in negotiating a settlement to the war, President Johnson announced he would not seek re-election. His vice-president, Hubert H. Humphrey, became the Democratic nominee and was defeated by Richard M. Nixon (1969-1974) who claimed to have a "secret plan" for honorably disengaging American troops. Many believe, however, that Nixon's "secret plan," which amounted to no more than a concerted effort to involve a greater number of South Vietnamese troops while simultaneously initiating a gradual American pullout, succeeded only to intensify the conflict. US participation in the war ultimately ended in March 1973 following several years of peace negotiations. To the dismay of many Americans, the void left behind was quickly and decisively exploited by the North Vietnamese. Under Gerald Ford's administration (1974-1977), Saigon, the capital of South Vietnam, was captured by North Vietnamese forces. Ironically, the dire predictions of the "domino effect" did not materialize. Only Vietnam and two neighboring countries, Laos and Cambodia, became communist.

Logistics Planning. The general logistical effort was incredibly well done in spite of enormous difficulties. Logistics planning for a war in Southeast Asia was accomplished prior to our involvement in Vietnam. In fact, logistics requirements were identified in plans which were "published as early as 1959 and revised in 1962 and 1963." (4:76) However, "action had not been taken to alleviate all the identified logistic shortfalls prior to the execution of combat operations." (4:76) Lieutenant General Joseph Heiser, Commander of 1st Logistical Command, Vietnam, made this assessment after specifically highlighting the lack of trained logistics personnel and adequate support organizations as prescribed by the plans. (4:76) The planning process did not provide for corrective action required to modify identified shortfalls. Without realistic plans, trained personnel, or organizations capable of providing combat support, the US "was unable to efficiently and effectively insert military power into Vietnam." (3:35)

As soon as troops and supplies began to arrive in-country, problems associated with logistical planning became evident. A common practice throughout the war was the "deployment of logistics support at the same rate as tactical units rather than in advance of them." (8:16) In fact, the procurement and subsequent delivery of equipment often came later than troop arrival. (7:229)

Infrastructure. Essentially, Vietnam had no existing in-country infrastructure for logistics use. (7:223;9:152) Poor ports, primitive highways, inadequate airfields, unreliable communications, and nonexistent transportation routes immediately confronted the troops arriving in Vietnam. In effect, "the US had to begin from square one to build a logistics system in-country along with all its necessary infrastructure elements." (7:223) Staggering problems faced logisticians. Inadequate planning for the accomplishment of logistics support was considerably apparent. Typically,

> ships had to wait in harbor for two or three months for off-loading. Then, finally off-loaded, supplies overflowed in the port shore facilities and could not be moved rapidly to point of storage or need. (7:240)

The magnitude of this regular occurrence is heightened through General Heiser's account during his Vietnam tenure:

> In the 1965-1966 time frame, as many as 100 ships with half a million tons of cargo stood off the Vietnam coast with no place to unload or store their cargoes. (4:77)

Manpower and Equipment. Unwarranted hardships were imposed on logistics planners when US officials decided not to immediately call up reserve forces. For example, without adequate advanced planning regarding personnel assigned to the theater, requirements determinations became a nightmare. Procurement lead times and distribution networks were affected. Supply storage and industrial production quotas were affected. Personnel recruitment was also affected. Table 1 reflects changes in personnel assigned to Vietnam.

Lessons Learned. Although the outcome was unexpected, the American effort in Vietnam fit well within the American tradition. Since the Civil War, the US Armed Forces have concentrated on the sciences of developing, deploying, and employing American's overwhelming resources. As a result, the US military has not had to be exceptionally clever in terms of military art because it could engulf its opponents in a sea of personnel, weapons, munitions, and other logistics. This is the tradition inherited from Ulysses Grant, who hammered away at General Lee in northern Virginia and overpowered the Confederate forces with the vast resources of the Union Army. The American military's traditional reliance on military science rather than on military art continues today. Why is all of this a matter of concern? The problem is that American tradition no longer fits reality. It was not a lack of power, as pointed out by President Nixon, that lost the Vietnam War.

Total US Military Personnel in Vietnam

Date	Total Personnel
31 December 1960	900
31 December 1961	3,200
31 December 1962	11,500
31 December 1963	16,300
31 December 1964	23,300
31 December 1965	184,300
31 December 1966	425,300
31 December 1967	485,600
31 December 1968	536,100
31 December 1969	474,400
31 December 1970	335,800
9 June 1971	250,900

Table 1. (5:14)

Instead it was the decay of national will attributed to the inconsistency of the political atmosphere in the United States. For example, early planning predicted a sizable force requirement (about 500,000) in Vietnam. It was not until 1968 before sufficient military forces were available in-country. Limited war, graduated response, and tit-for-tat ideas, in concert with effective gamesmanship, obstructed the underlying purpose of America's intervention in Vietnam. (2:75) Hence, no clear statement of purpose or role for deployed US armed forces was evident. In fact, funding in FY65 was limited to only $1.7 billion, far less than the budgeted $11.2 billion required to sustain activity. (2:75) Furthermore, multiplied draft calls were favored to calling up the Ready Reserves—forces already organized, trained, and equipped for duty. The deployment of essential military forces, due to new recruit training, organizing, and equipping, was delayed—the war, prolonged. Unsurprisingly, casualty rates in-country steadily rose while support back at home steadily declined.

As if enough problems were not confronted on a daily basis by those in-country, other problems were frequently encountered, compounding an already deplorable situation. For instance, the enemy was afforded sanctuary in Cambodia, Laos, and its own home (North Vietnam). Enemy forces could be concentrated on US weak points at will. If hurt, the enemy could flee back into its sanctuary until healed. The enemy could fire rockets and artillery from its sanctuary with no fear of US intervention (the US could shoot back, but could not "search and destroy" the enemy). Additionally, intelligence reports clearly identified the massive buildup of enemy airfields and antiaircraft defense installations. Nevertheless, US forces were not permitted to attack such emerging defenses in fear of Chinese retaliation. As a result, Hanoi possessed one of the finest air defense systems in the world and, in turn, became "a depository for downed US aircraft; Hanoi prisons were filled with downed US pilots." (2:77) In response to a humanitarian need to allow enemy Viet Cong to "visit" their homeland, periodic "cease-fires" were commonplace. Visitation was not the only activity during these fighting lulls. The massive, surprise Tet offensive in 1968 was the capstone of the enemy's deceptive use of the cease-fires to reestablish its presence over larger areas with resupply, recruiting, and reorganization. (2:77) Still, other problems, other disasters, and other bad decisions reigned supreme in the Vietnam War. Pressures to end the war and the decision by prominent TV anchormen that "it was time to get out of Vietnam" brought about a program of premature withdrawals. As pointed out by USMC General Raymond Davis:

> Had it been clear from the beginning that [the role of US forces was] to destroy the enemy forces, it would have been equally clear in 1969 that our mission had not been accomplished. (2:78)

Some years later, Secretary of Defense Caspar Weinberger stated:

> The problem [with Vietnam] was we didn't want to win that war. We never intended to win that war.... If it isn't important enough to win, it is not important enough to be there. (6:355)

To commit America's military forces and then withhold support is to betray those men and women who so bravely serve this great land. When America goes to war, America must go to win—it is that, or stay at home.

References

1. Bender, David, and Bruno, Leone, editors. *The Vietnam War*, San Diego CA: Greenhaven Press, 1990.
2. Davis, Raymond G., General, USMC. "Politics and War: Twelve Decisions that Rendered Defeat in Vietnam," *Marine Corps Gazette* (August 1989), pp. 75–78.
3. Dilla, Benjamin L., Major, USAF. "Logistics Support Limitations in the Vietnam War: Lessons for Today's Logisticians," *Air Force Journal of Logistics*, 14 (Fall 1990), pp. 35–37.
4. Heiser, Joseph M., Lieutenant General, USA. "Vietnam Logistics: Past is Prologue?" *Defense Management Journal*, 12 (July 1976), pp. 74–80.
5. Heiser, "Logistics Support," Department of the Army, Vietnam Studies, Washington DC: 15 December 1972 (published 1974).
6. House of Representatives. *Department of Defense Appropriations for 1982: Hearings Before a Subcommittee of the Committee on Appropriations*, 94th Congress, 1st session, 1981.
7. Peppers, Jerome G., Jr. *Military Logistics: A History of United States Military Logistics 1935-1985*, Huntsville AL: Logistics Education Foundation Publishing, 1988.
8. Quirk, John T., Lieutenant Colonel, USAF. "An Analysis of Air Force Logistics Shortfalls of the Vietnam Buildup of 1965-68 as an Indicator of Shortfalls in Future Conflicts," unpublished research report, Air War College (AU), Maxwell AFB AL, 1980.
9. Rutenberg, David C., Lieutenant Colonel, USAF, and Allen, Jane S., editors. *The Logistics of Waging War: American Logistics 1774-1985*, Maxwell AFB AL, Air Force Logistics Management Center, undated, issued December 1986.
10. Santayana, George. "Reasons in Common Sense," *Life of Reason*, Cambridge, Great Britain: University Printing House, 1980.

Captain Jack E. King, Jr., wrote this article while a graduate student at AFIT. He is presently assigned to Warner Robins Air Logistics Center, Robins AFB, Georgia.

Are We Overlooking "Logistics"?

As I review the current literature of the logistics world, I am struck by two thoughts: One, there is very little literature attempting to explain, or further the understanding of, logistics in its overall sense as a system. And, two, there is a paucity of literature on the people element of the logistics system.

The emphasis today is on the technical aspects of specific process systems, the computer, and quantitative approaches to management and logistics. But, little or nothing is devoted to exploring what "logistics" is all about or why the people working in the logistics systems behave as they do. In fact, many "logistics specialists" tell me it is not important to consider the people elements of logistics—good management will take care of that and the real need is on statistical controls to help management. I believe this outlook is probably the cause of our loss of stature as a profession and could be fatal to our desires for overall logistics effectiveness improvements. Could this approach also be the reason we are looked upon as "bean counters" by those outside the profession?

I have no question about the importance of the computer to the world of logistics. Certainly we need, and must have, competent specialists in this discipline. The same is true of quantitative methodology and processes. But, make no mistake, the computer is *NOT* logistics! Quantitative techniques are *NOT* logistics! Computer programs and computer-driven, or aided, systems are *NOT* logistics! All of these assist managers in logistics, or course; but they are nothing more than contributory functions to the operation of the logistics system. Again, though, I must remind you, these contributory elements are *NOT* logistics—not even collectively!

LOGISTICS is a system established to create and sustain some specified capability.

For this article the system would be established to create and sustain military capability. But, it could be the capability to produce, distribute, sell, and service a particular product or set of products. Or, it might be the capability to provide a defined service or set of services such as healthcare. Therefore, it should be obvious this system, logistics, is far more expansive than merely a process, a formula, a simulation, or a program.

Unfortunately, much of the attention given this topic in the last 25 years has been to create increasingly more specialized processes and people who are highly competent in their individual skill areas but unaware of the greater logistics system they serve. Far too many of our people think that competent on-job behavior makes them, in fact, "logisticians." Nothing could be further from the truth, but we have no literature guiding or leading people into greater understanding of just what logistics is all about. So, it might be understandable that such misconceptions exist.

We certainly need action on this topic and a good place to start is with the *Air Force Journal of Logistics*. Perhaps this article might generate some response and reaction leading to further thought in the hallowed halls of the Pentagon and Air University. Review, if you will, the topics covered in the symposia, conferences, and technical meetings of logistics in the last 10 to 15 years. Review, also, the subjects covered in articles in logistics professional journals. You will find the preponderance of coverage is on those computer, and quantitative, and simulation topics. The new ideas hailed by these journals and assemblies almost always lie in the fields of numbers and scientific process. Very rarely are there topics on the concepts and philosophies of logistics or on the people aspects of our profession.

We need more on how people function—what makes a person tick. The key to logistics success is and always has been people. Organizations do nothing. In fact, they exist only in the minds of people. Systems do nothing to create and sustain capability if they do not have the support of the people. I realize I speak the obvious when I say nothing gets done unless people act. Yet, we in military logistics, seem willing, almost eager, to forget to consider people when we think of "doing our job." Our trend toward specializing our people, particularly our leaders, at the expense of lost generalizing development causes a great many of our long-lasting problems.

When we speak of logistics management, we most generally apply that thought to the control and direction of systems or processes. We truly should think of logistics management as the guidance, direction, development, and control of the people who accomplish all the essential tasks successful military logistics demands. Again, to repeat the obvious, systems, processes, and methods have little value unless they are activated in the minds of our people.

Unfortunately, much of the attention given this problem in the past 25 years has been to create increasingly more specialized processes and people. The people have become exceptionally competent in their individual skill but more unaware of the logistics systems they serve. Far too many of our logistics people now think on-the-job competency makes them "logisticians." Nothing could be further from the truth, but we have no literature guiding these people to fuller understanding of just what logistics is all about.

Without going into great detail, if we would accept for now the definition of logistics offered, we could begin to recognize the scope of our profession. To create and sustain military capability we need, for example, people. Therefore, a large portion of the military logistics coverage is immediately established. How can we have people without recruiting? Without training? Without medical care and hospitalization? Without food service? Without clothing and weaponry? Without housing? Without pay and promotion and recordkeeping? Without mortuary services and graves registration? Without some forms of recreation? To acquire all these coverages, of course, we need much more; for example, construction, utilities, transportation, supply, distribution, maintenance, procurement, and weapon system acquisition. My only point at this time is to establish a beginning of understanding the expanse of military logistics which very few today seem to grasp.

In fact, I have had personal experience with faculty members in one of our senior schools advising logistics students not to register for a logistics history course because it was, in their words, "soft and not useful." In its place, these faculty members recommended another quantitative course, another computer course, or another simulation course. Why? Because they claimed these technical courses were more "logistics oriented"

than was knowledge of the historical problems and accomplishments of the profession.

Further, I find no evidence of exhaustive study of military logistics concepts and philosophies, the real meat of understanding, in any educational program of the United States Air Force—not in any of the professional military education programs, not in any Air Training Command course, not in any Air Force Institute of Technology program. How can we expect to develop true logisticians if we do not educate them and if we encourage only their single skill specialization?

In this view of military logistics, it soon becomes obvious all of the United States Air Force is logistics except for those who crew the weapon systems we possess. Pilots, navigators, aircrews, and missile crews, and possibly military intelligence, are those we in logistics serve as we create and sustain military capability.

I would like to see all junior, nonrated officers (and their civil service contemporaries on initial jobs) assigned to specific skill duties in logistics for their first four years of active duty. Then, I would suggest they be required to state their intentions relative to the remainder of their Air Force careers. Those who choose to do so may remain technicians with the understanding they have limited advancement potential—perhaps no greater than to lieutenant colonel and positions no higher than the equivalent of numbered air force.

Those who choose to become logisticians would be detailed to attend a developmental logistics educational program in which they would read and discuss some of the conceptual literature of logistics. Thus, by reading and discussing the works of Admiral Eccles, James Huston, Martin Van Creveld, Graham Rider, Robert Goralski, Roland Ruppenthal, and others, a sound basis of understanding the scope of military logistics would emerge. Further, some of these young officers (and their civil service contemporaries) would have thoughts of their own, would begin to write and challenge, and would begin to establish a newer, stronger logistics force for the future.

What then? After their first four years of specialist duty, and following their educational period (perhaps six months in length), they would become "Logistics Officers" assignable to any job in the Air Force other than the operational positions cited. Specialization would not be their role. Generalization would. In this manner, these officers, and comparable civil service personnel, would be managers and leaders but not doers! As they acquired more years of service, they would be assigned to other jobs with effort made to assure their continued broadening. They would eventually become "logisticians" capable of understanding and guiding military logistics forces of any size or complexity. These would be the logisticians assigned to senior positions at our highest levels. They would become the planners and conceptualizers for military logistics. Further, they would become effective developers of their subordinates because their subordinates would be the specialists and doers likely spending their entire careers in a given specialty effort.

To accomplish this would require a major change in the way top Air Force people view their juniors. But, to develop real officers, and true logisticians, would make it all worthwhile. There would be more to the program than I have mentioned here, but enough has been said to point the way. I believe it is time we move ahead to accomplish this expansion of our logistics profession for the greater benefit of the Air Force and the United States.

"A Logistics Warrior"

(Continued from page 30)

7. AFM 2-4, *Tactical Air Force Operations Tactical Airlift*, Washington: HQ USAF, 10 August 1966.
8. Goldratt, Eliyahu M. *The Haystack Syndrome: Sifting Information Out of the Data Ocean*. Croton-on-Hudson, New York: North River Press, Inc., 1990.
9. Goldratt, *What Is This Thing Called Theory of Constraints and How Should It Be Implemented*? Croton-on-Hudson, New York: North River Press, Inc., 1990.
10. Juran, J. M., and Gryna, Frank M. *Quality Planning and Analysis: From Product Development through Use*, New York, New York: McGraw-Hill, Inc., 1980.
11. Kast, Fremont E., and Rosenzweig, James E. "General Systems Theory: Applications for Organizations and Management," *Management and Organizational Behavior Classics*, edited by Michael T. Matteson and John M. Ivancevich, Homewood, Illinois: Richard D. Irwin, Inc., 1989.
12. Loh, General John M. "Advocating Mission Needs in Tomorrow's World," *Airpower Journal*, 6 (Spring 1992), pp. 4-13.
13. Umble, Dr M. Michael, and Dr Srikanth, M. L. *Synchronous Manufacturing: Principles for World Class Excellence*, Cincinnati, Ohio: South-Western Publishing Co., 1990.
14. 388th Tactical Fighter Wing (Provisional) Logistics Plans Division, Log Book, Al Minhad Air Base UAE, January 1991.

Captain Cummins wrote this article while attending the Air Force Institute of Technology. He has since separated from the Air Force and is presently National Standards Administrator, Uniform Code Council, Inc., Dayton, Ohio.

AIR FORCE JOURNAL of LOGISTICS

AIR FORCE MATERIEL COMMAND

MATERIEL DIVISION
U.S. ARMY AIR CORPS

AF LOGISTICS COMMAND

AIR MATERIEL COMMAND